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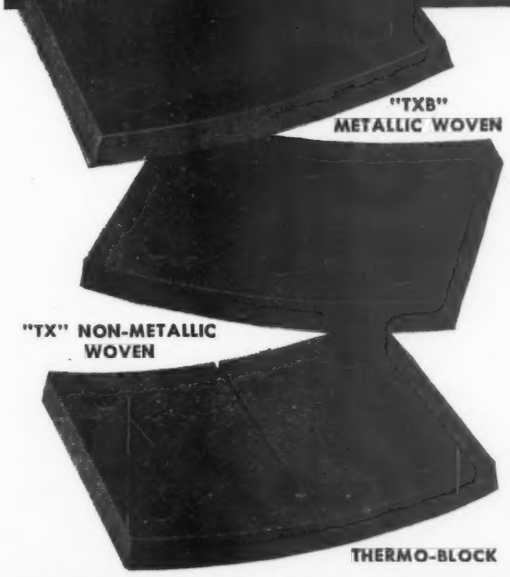

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The Course of Oil

by K. C. SCLATER

SERVICE COMPANY ENGINEERING

A service company in the oil industry is an organization set up to perform a specialized task for the oil operator both large and small for a fee, which is usually less than the operator would have to spend in performing the work himself and great enough for the service company to realize a reasonable profit.

The broad acceptance of the many specialized services in existence today is proof enough of their practicality and legitimate position within the industry. By and large the many service companies have recognized the implications and responsibilities of that word "service" and have extended service facilities to a point where they are readily available within the active oil areas and reasonably available to the more remote frontiers.

By reason of their extensive experience with wells of every description in every part of the country they have built up a fund of knowledge pertaining to the application of their various services, which is of real value to the users, none of whom have operations so numerous and so widely scattered as to provide equivalent experience.

Service, therefore, goes beyond the mere making available of service facilities. It includes, or should include, the utilization of this experience in the continued improvement of those facilities and the adaptation of this experience to the particular needs of the user. This is a job of systematic observation and study; recognizing and isolating problems, and the application of physical laws and scientific methods to the development of practical solutions.

The engineer is being utilized by large and small operators in the oil, gas, and natural gasoline divisions of the oil industry.

The growing complexities of operations within these divisions have led to the development of engineering departmentalization and engineering specialists within these departments.

The service company, in the fulfillment of its responsibility to the oil industry of which it is a part and from which it draws its subsistence, has, in much the same manner, enlarged its engineering structure and in the process created departments and specialists within these departments.

In the field we have operating engineers, who are usually unknown to the oil operator, but who are responsible for such things as field testing of new equipment, improvement of existing equipment, the maintenance of standards of inspection and procedure necessary to our type of operations, and, of course, the research and continued development of such systems as well as depth measurements.

Within this group are specialists in radio-activity logging, who must have a thorough knowledge of electronics, and to some extent of nuclear physics. Their efforts are similarly directed toward testing of new equipment, improvement of existing equipment, maintenance of standards of inspection and procedures.

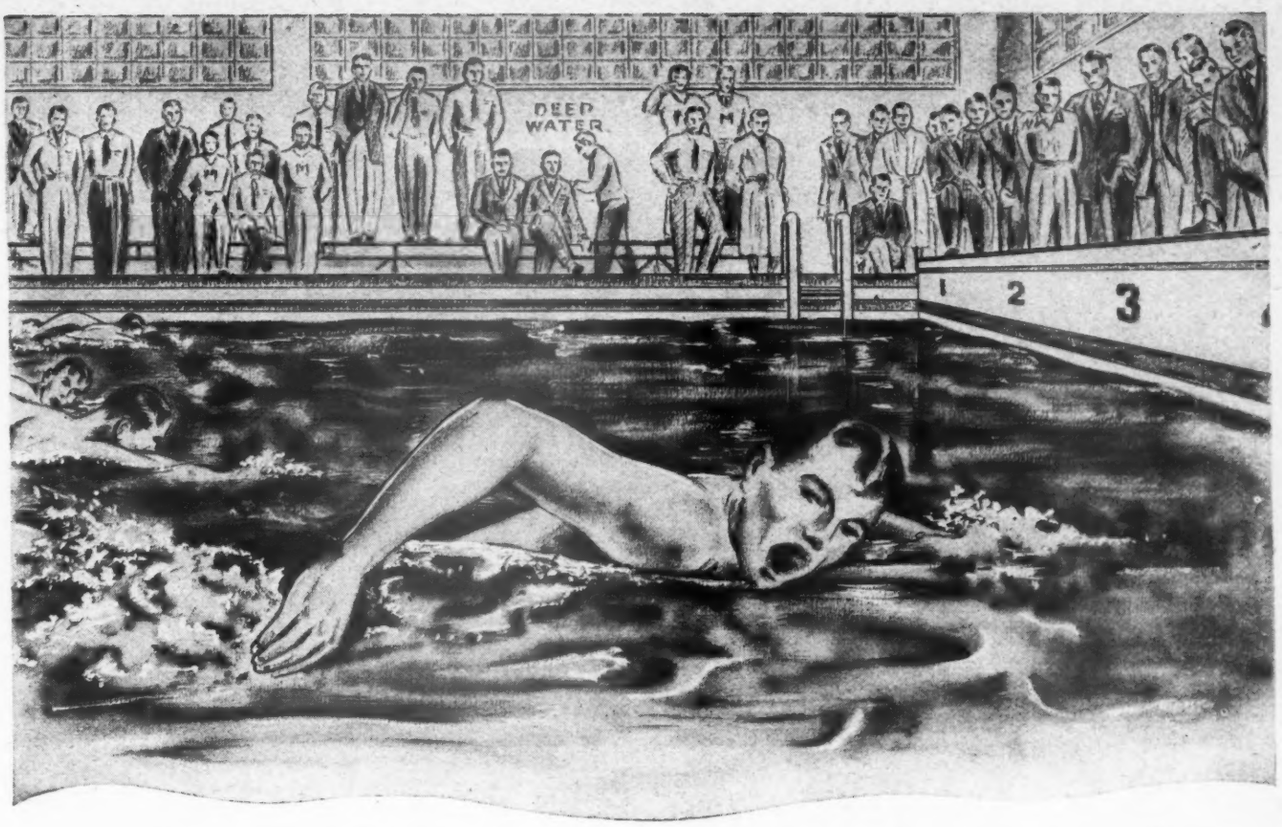
Interpretation of service includes the adaptation of experience to the particular needs of the user. This thought can be further fostered and much mutual benefit could be gained from a closer contact of the oil and service company engineers, concerning immediate or foreseen problems and requirements. This contact has been possible to a degree through the technical societies and local engineering groups, but from an overall standpoint this contact has not permitted of the closer relationship that now seems necessary.

With the most intimate knowledge of requirements the sales engineer is prepared, as a specialist, to discuss with the user the particular service application and to make specific recommendations on techniques and equipment most logical to obtain the desired results. Because trained engineers can best understand the factors contributing to specific well problems and can best utilize engineering tools and aides to the solution of these problems, they make excellent service company representatives at that point of contact between service company and user.

So, even in the field of sales we have set up research engineers and geologists whose specialized task it is to enlist the aid and cooperation of the users in submitting certain bits of isolated information upon specific questions they may possess so that a little here, a little there, these jigsaw bits of knowledge can be coordinated into a recognizable pattern from which helpful conclusions may be drawn for the ultimate benefit of the industry in general.

The foregoing remarks were made recently in addressing a group of oil men by Norman L. Dorn, engineering executive of a prominent service company rendering specialized services to the oil industry.

Besides making available service facilities, a service company applies its cumulative experience to improving its service facilities. It is this concentration of effort on specific problems on the part of service companies that has led to their playing so important a role in advancing oil industry practice.



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Scanning WASHINGTON'S OIL HORIZON

By MILBURN PETTY

WASHINGTON—Oil use of one—or both—of the Big Inch pipe lines becomes more and more probable as the day of decision nears with War Assets Administration scheduled to open bids July 31 for disposal of the government-owned lines.

The situation has changed radically from last fall when an industry committee recommended against use of either line for oil and it was freely predicted that oil use was "impossible" because the major companies were not interested.

Principal factor in oil use becoming an odds-on bet has been the flatfooted determination of J. S. Jenner, WAA official handling pipe line disposal, to carry out WAA's policy decision that national security requires the Big Inch lines be kept available for use in any national emergency. Best way to do that, WAA concluded, was to continue the lines in oil service.

Another contributing factor was that a non-oil group, backed by a huge wad of cash, was so anxious to obtain the Big Inch right-of-way for a new 30-inch natural gas line into the New York area that they were willing to operate one or both of the present lines in common carrier oil service. Heading this group, incorporated as Big Inch Gas, Inc., with an affiliate, Big Inch Oil, Inc., was Charles H. Smith, New York. The financial backing comes from Christopher T. Chenery, who recently disposed of his Southern Natural Gas holdings. B-I-G has contracted with eastern utilities to supply enrichment gas, if its proposal is accepted by the government.

Other groups with idle cash also got the idea that the Big Inch lines might be worthwhile investments in this era of low-interest rates.

From the start, one or two major oil companies had indicated they would be interested in using the Big Inch Lines if someone else succeeded in working out an operating plan. Subsequently, one of these companies initiated a group operating plan. A few weeks after word of this leaked out the company let it be known that it was backing away from the idea.

Always, there was the possibility that independent refiners and co-operative refiners within reach of the Big Inch lines might join up to provide the volume needed. Indeed, WAA was planning as a last resort to sponsor a get-together on such a joint venture. Apparently, it turned out that this wasn't necessary.

WAA's insistence on holding the lines for oil use was vindicated early in June when the prospective shipping strike threatened to cut off supplies to the East Coast and President Truman ordered plans drawn for putting the lines back into service in case the tankers were halted.

Apparently, the shipping strike threat served as a warning to some oil companies that it would be better not to have all their eggs in one basket. Also, higher wages for seamen means increased tanker costs, making pipe lines attractive for still another reason.

Now, the bandwagon is rolling toward oil use. The scramble to get aboard may become so spirited that WAA will have to earmark space in the lines for independents. The bugaboo of crude supply for the lines is vanishing as more of the majors become interested. But there is still talk of a feeder line from West Texas.

Once the idea of using the Big Inch as a crude oil carrier was accepted as possible, if not probable, there were feelers from Midwestern majors, and independents, Ohio Valley refiners and even from Pennsylvania. One idea discussed was for a branch line running up to the lake refineries and on into Michigan.

Some companies, while desiring to utilize the Big Inch lines, shy away from any joint operating venture lest they run afoul of the antitrust laws, especially in light of recent court decisions and expressions of opinion by Administration leaders.

So, it is anybody's guess what sort of operating plan will be worked out. But one thing sure, the odds now favor at least one line for oil, with even money being bet that both will be oil carriers.

● **POSTWAR COUNCIL.** Industry leaders on the National Petroleum Council, the new 85-member group set up to advise Interior Department's new Oil and Gas Division, are proceeding cautiously in their organization plans. At the first NPC meeting June 21, a majority favored going ahead although wanting to know more about where they were going and why.

Some NPC members felt that the new oil and gas unit, hub of a program for centralizing all the government's petroleum activities in Interior, might be the first step toward federal oil control. Others feared that the "green light" letter reluctantly issued by Attorney General Clark wasn't a sufficient guarantee that another Madison oil case wouldn't result from the Council's activities.

On the other hand, President Truman had instructed Interior Secretary Krug to set up the Council. And judging from the number of unsuccessful candidates for membership, there wouldn't be any difficulty filling vacancies. Then, too, there is always some advantage to being "on the inside" of policy making. So, there will be a council despite considerable behind-the-scenes opposition from some industry quarters.

● **API SUIT.** Negotiations for a consent decree in the "Mother Hubbard" suit against the American Petroleum Institute and some 300 major oil company defendants were broken off in June when the Department of Justice's proposals were rejected. Another proposal may be forthcoming from the DJ but there are several companies that are seemingly adamant in their insistence on going to trial.

It is unlikely that the DJ would go to trial with the 1940 complaint. So, if no out-of-court settlement is reached the chances are that the outmoded complaint will be dismissed in favor of one or more new actions covering various phases of the original complaint, plus several other ideas that have been cooking at the DJ such as the cracking patent investigation.

● **CONCENTRATION.** The oncoming elections, plus President Truman's recent remarks about "making little ones out of big ones," have spurred interest in small enterprise.

No sooner had word got around that the Senate Small Business Committee was coming out with a report on how industrial concentration had increased during the war than the House Small Business Committee got busy with plans for investigating concentration. A subcommittee was named, headed by Congressman Kefauver, Tennessee, which is now contacting the downtown departments—Department of Justice, Federal Trade Commission, Commerce Department, etc.—to see what they are doing about it. (And if they haven't much to show, it's a safe bet that they will start something or else answer when their appropriation bill comes up next time.)

The Senate committee is putting out feelers about a joint congressional investigation of concentration, asking about bringing up-to-date information on the oil industry, for example, such as presented to the anti-monopoly probe (TNEC) in 1939.

(P. S. The report already issued by the Senate Small Business Committee, prepared by the now-defunct Smaller War Plants Corporation, contained some scorching editorial comment on "domination" of the oil industry by "the giants".)

● **POSTSCRIPTS.** Department of Justice has approved sale of the 82-mile Ohio Emergency Pipe Line to the Ohio Standard without insisting on common carrier operation . . . Naval Petroleum Reserves reports its test well at Umiat, Alaska, was down 2,287 ft. on June 23 . . . Tide Water purchased 320,000 bbl. of surplus 100-octane at 7.38 cents per gal. . . . U. S. Geological Survey will soon issue a new map showing oil and gas fields including pipe lines . . . Mastin White, of Texas, will be the new Solicitor of Interior Depatment . . . Puerto Rican interests, with American backing, are seeking equipment for a refinery to operate on Venezuelan crude.

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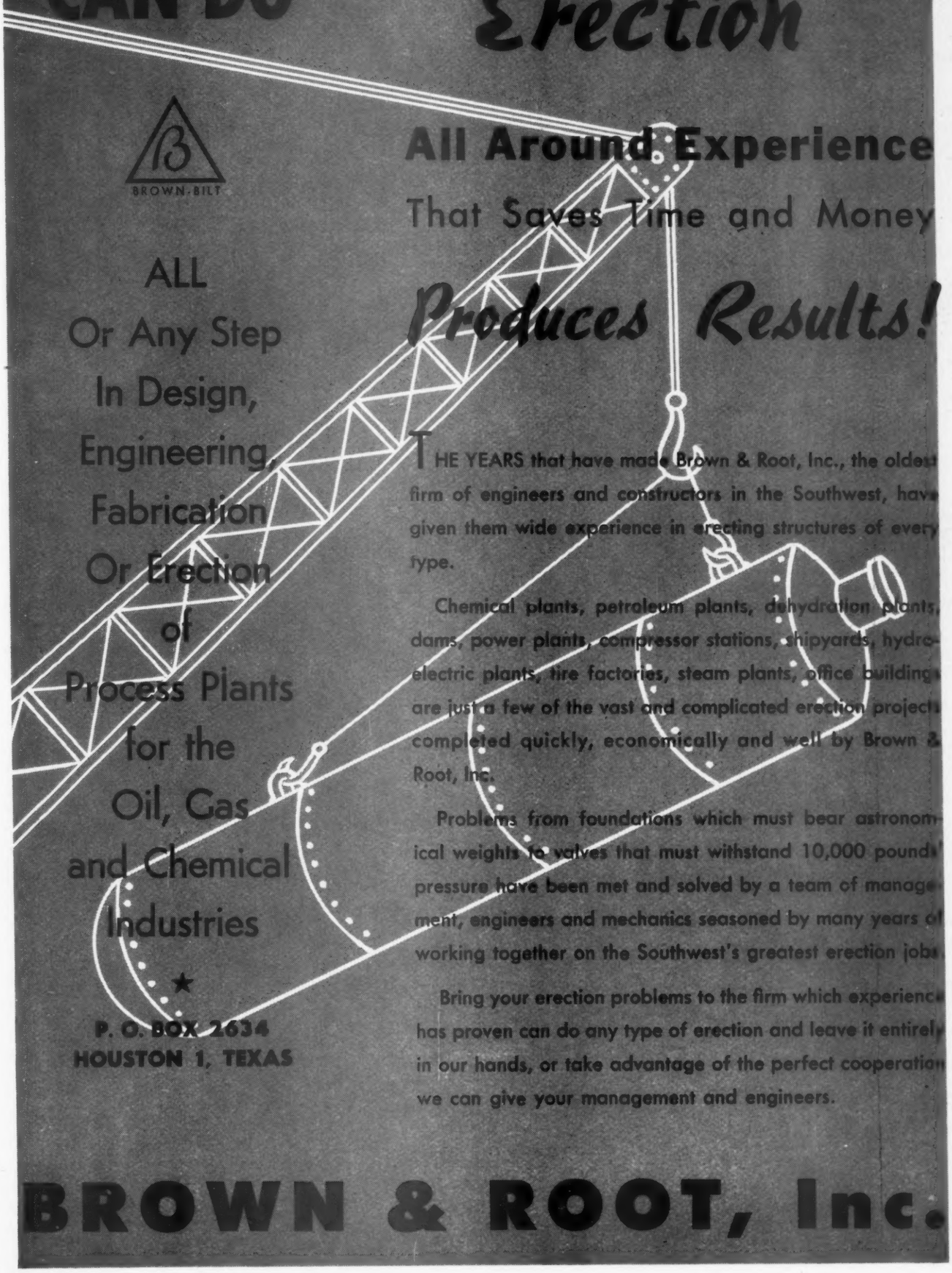

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NATIONAL PETROLEUM SITUATION

IMPORTS UP 32 PER CENT. Imports of crude oil in the first half of 1946 aggregated about 41,500,000 bbl., against a total in the first half of last year of 31,497,000 bbl. This is an increase of about 32 per cent. The daily increase over last year is about 55,000 bbl. Refined oil imports also increased 1,626,000 bbl. over last year, or nearly 9000 bbl. daily.

STOCKS UP 20 MILLION BARRELS. Combined stocks of crude and refined products on June 30 were about 20,339,000 bbl. above a year ago. Stocks of refined products are 8 per cent above last year while crude stocks are about 1 per cent greater. Gradual improvement in the industry's overall stock position brought the total to within 5 per cent of maximum working levels currently required.

DRILLING ABOVE EXPECTANCY. Well completions in the first half of 1946 exceeded expectancy by 191 drill holes, or about 1 per cent. Completions in first half were 13,766, compared with 12,781 last year, which is about 8 per cent greater. Wildcat operations were about 4 per cent under last year. On the basis of 5000 wildcats scheduled for 1946, completions in the first half should have been 2480, whereas the industry actually drilled only 1933 wildcats during this period. This is about 22 per cent under quota.

SUPPLIES EXCEED DEMAND. Analysis of supply and demand of all oils in the first half of 1946 indicates that supplies exceeded demand by about 3 per cent. Total demand in the first half was about 5,210,000 bbl. daily, while the total supply of all oils was 5,363,000 bbl. daily. Refining operations were at the daily rate of 4,695,000 bbl., while actual requirements were about 4,636,000 bbl. These facts emphasize the degree to which the petroleum industry has adjusted its economic position over the last 6 months.

FUEL OIL ADJUSTED. Marked improvement in the fuel oil position was shown in the first half of 1946. Stocks on June 30 were 17 per cent above a year ago and represented 40 days supply against only 32 days supply a year ago. Decreased demand by the Navy and refinery yield adjustments, effected the improved stock position.

INCREASED PRODUCTION. June crude production increased about 183,000 bbl. daily over May, averaging 4,920,000 bbl. Texas led all states with an increase of 114,000 bbl. daily. Production in the first half of 1946, however, showed a net decline under the first half of 1945 of 129,000 bbl. daily. Texas and California recorded a combined decrease in production under last year of 162,000 bbl. daily.

Comparative Statistics, June, 1946

*All figures are computed on a Bureau of Mines' Basis**

	June 1946(p)	May 1946	June 1945	This year to date(p)	Last year to date	Per cent change
Wells drilling	3,610	3,570	4,300	3,610	4,300	—16
Total wells drilled	2,492	2,423	2,349	13,766	12,781	+ 8
Development wells	2,148	2,082	1,970	11,833	10,774	+10
Oil	1,324	1,272	1,220	7,343	6,637	+11
Gas	232	212	210	1,257	1,169	+ 8
Dry	592	598	540	3,233	2,968	+ 9
Per cent dry	27.6	28.7	27.4	27.3	27.5	— 0.2
Wildcat wells	344	341	379	1,933	2,007	— 4
Oil	37	51	32	279	269	+ 4
Gas	12	9	12	56	65	—14
Dry	295	281	335	1,598	1,673	— 4
Per cent dry	85.8	82.4	88.4	82.7	83.4	— 0.7
Crude production	147,600	146,850	146,610	846,537	869,802	— 3
Daily average	4,920	4,737	4,854	4,677	4,806	
Crude demand	155,340	158,150	156,182	885,400	904,807	— 2
Daily average	5,178	5,102	5,206	4,892	4,999	
Crude stocks	226,360	227,100	223,262	226,360	223,262	+ 1
Days supply	44	44	43	44	43	
Natural gasoline production	9,550	10,300	9,281	57,716	56,125	+ 3
Daily average	318	332	309	319	310	
Motor fuel production	62,480	63,860	66,968	366,807	400,624	— 8
Daily average	2,083	2,060	2,232	2,027	2,213	
Gasoline yield, per cent	37.6	37.2	39.4	37.6	40.4	— 2.8
Motor fuel demand	66,020	67,670	70,532	370,689	401,075	— 8
Daily average	2,201	2,183	2,351	2,048	2,216	
Motor fuel stocks	89,800	93,340	78,812	89,800	78,812	+14
Days supply	41	43	34	41	34	
Fuel oil production	61,890	63,660	62,418	370,174	365,262	+ 1
Daily average	2,063	2,054	2,081	2,045	2,018	
Fuel oil demand	58,915	61,810	63,962	374,860	419,568	—11
Daily average	1,964	1,994	2,132	2,071	2,318	
Fuel oil stocks	79,300	71,025	68,046	79,300	68,046	+17
Days supply	40	36	32	40	32	
Refinery still runs	145,350	149,200	149,682	849,800	871,436	— 2
Daily average	4,845	4,813	4,989	4,695	4,815	
Refinery stocks	238,430	230,111	221,189	238,430	221,189	+ 8
Days supply	47	45	40	47	40	

*Unless otherwise stated all figures represent thousands of barrels.
¶Revised.

Economic Position of U. S. Petroleum Industry

Six Months Ending June 30, 1946

	Normal¹	Actual	Per cent of normal
Drilling*** (wells completed)	13,575	13,766	101
Production (daily crude output)	4,662	4,677	100
Refining (daily still runs)	4,636	4,695	101
Stocks (crude and refined)	487,060	464,790	95
Price of crude (per bbl.)	$2.10	$1.31	62

Crude Prices by States for June, 1946

U. S. average	$1.31	Louisiana	$1.37
Texas	1.31	Arkansas	1.17
California	1.16	New Mexico	1.10
Oklahoma	1.33	Mississippi	1.12
Kansas	1.32	Illinois	1.49
		Other states	1.99

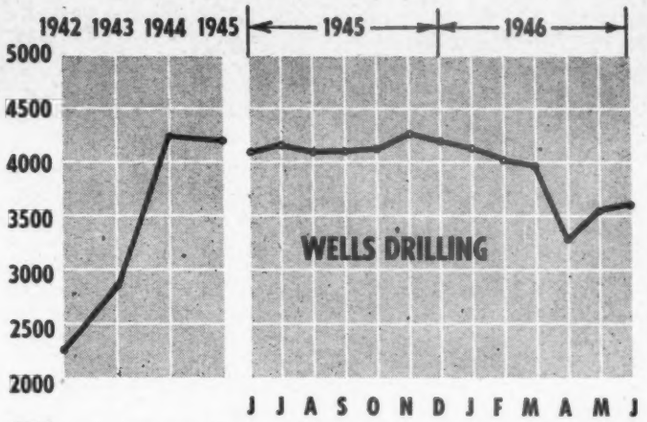
Basic crude prices

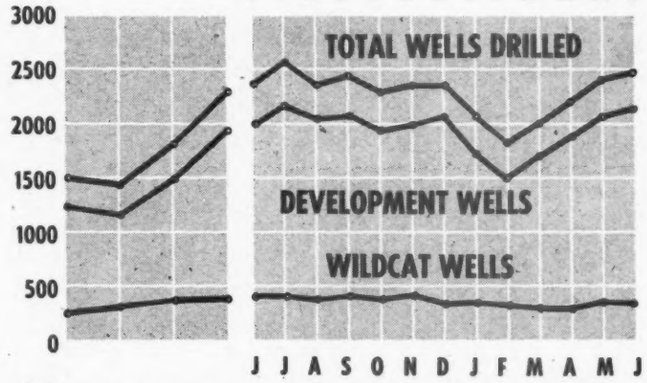
Oklahoma-Kansas (36 gr.)	$1.37
Texas Gulf Coast (36 gr.)	1.50
East Texas	1.35
West Texas (36 gr.)	1.14
Calif. Signal Hill (26 gr.)	1.21
Pennsylvania, Bradford	3.10

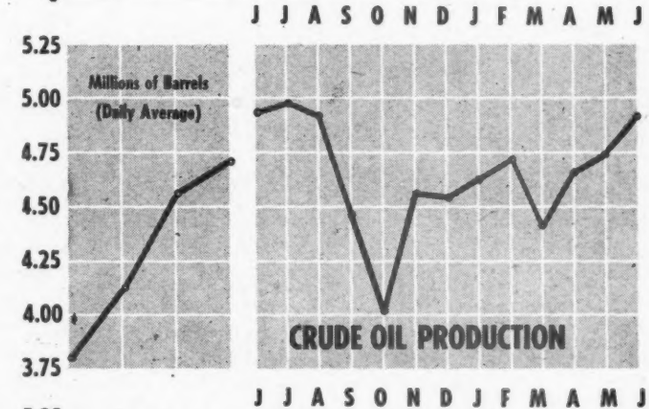
Drilling and Production Statistics by States

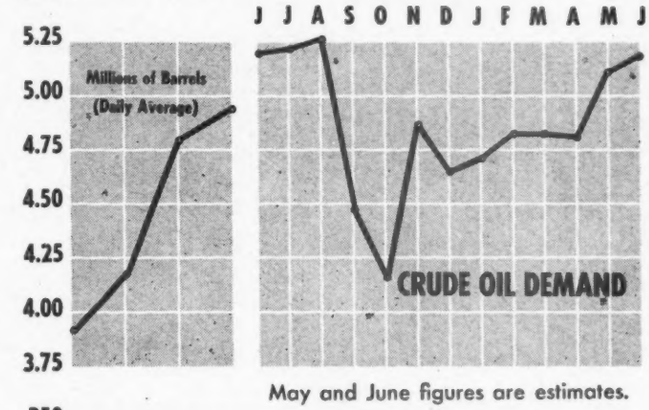
	June 1946(p)	May 1946	June 1945	This year to date(p)	Last year to date	Per cent change
Total wells drilled	2,492	2,423	2,349	13,766	12,781	+ 8
Texas	675	719	611	3,952	3,486	+13
California	155	147	186	901	1,154	—22
Oklahoma	224	185	219	1,172	1,173	0
Kansas	158	169	164	952	802	+19
Louisiana	92	128	124	631	548	+15
Arkansas	18	12	12	87	76	+14
New Mexico	35	24	27	188	217	—13
Mississippi	38	19	32	136	172	—21
Illinois	187	175	155	1,050	794	+32
Other states	910	845	819	4,697	4,359	+ 8
Wildcats drilled	344	341	379	1,933	2,007	— 4
Texas	139	157	131	760	791	— 4
California	16	14	26	110	114	— 4
Oklahoma	36	26	45	210	225	— 7
Kansas	26	23	42	138	189	—27
Louisiana	14	17	19	113	85	+33
Arkansas	5	5	2	18	22	—18
New Mexico	2	5	5	28	35	—20
Mississippi	15	2	9	41	61	—33
Illinois	34	32	39	194	157	+24
Other states	57	60	61	321	328	— 2
Daily crude production	4,920	4,737	4,854	4,677	4,806	— 3
Texas	2,240	2,126	2,161	2,058	2,164	— 5
California	880	865	942	860	916	— 6
Oklahoma	380	369	384	378	373	+ 1
Kansas	267	261	268	258	268	— 4
Louisiana	378	381	361	377	355	+ 6
Arkansas	73	74	79	76	80	— 5
New Mexico	100	96	102	98	104	— 6
Mississippi	63	62	51	58	51	+14
Illinois	207	202	207	206	207	0
Other states	332	300	299	311	288	+ 8

(p) Preliminary. ***Does not include input wells.

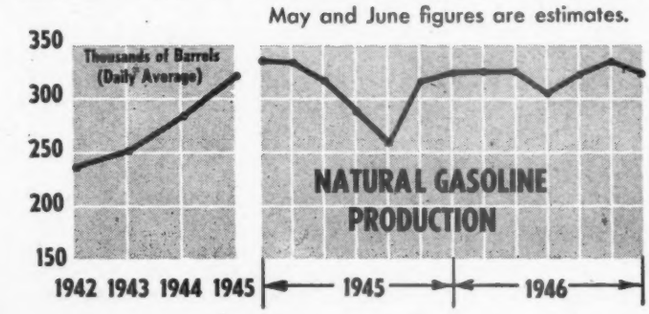


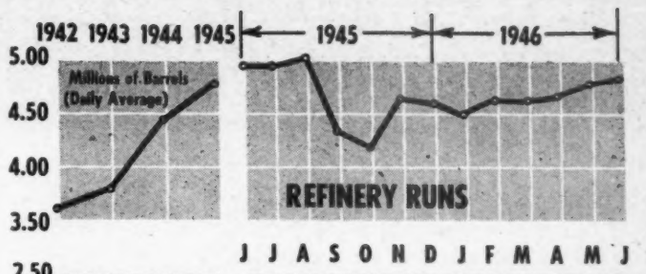


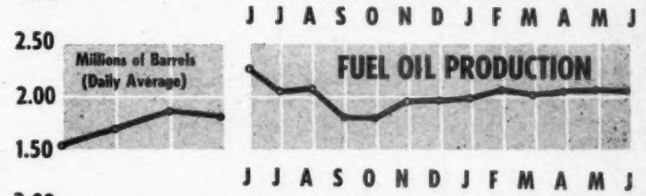


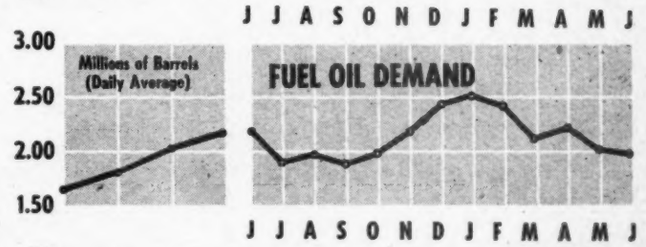


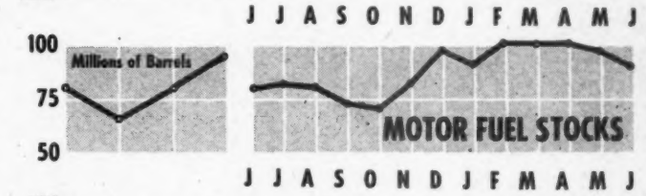
May and June figures are estimates.

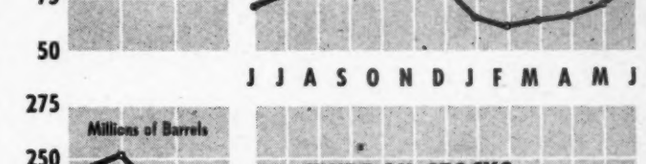




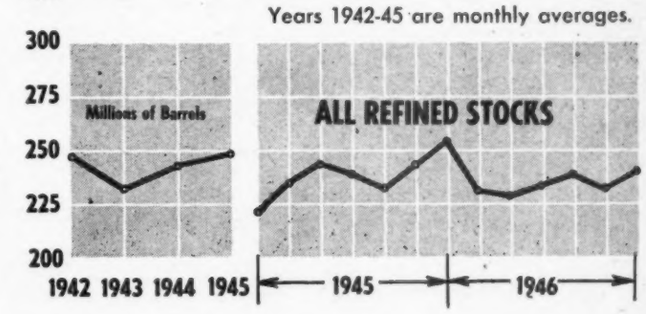








Years 1942-45 are monthly averages.



Highlights IN OILDOM

● **ENDING OF OPA WILL NOT AFFECT PRICES OF PETROLEUM PRODUCTS, SAYS BOYD.** "The prices of petroleum products has always depended upon the costs of production and the ceaseless competition between oil companies rather than upon OPA edict," said William R. Boyd, Jr., president of the American Petroleum Institute, in commenting upon the removal of arbitrary price controls.

"The past performance of the American petroleum industry in raising the quality and reducing the price of its products is the best assurance the public can have that those services will continue," Boyd added.

"Prices of gasoline and oil products have always been determined by costs, by free competition among hundreds of active and efficient oil companies. Like most typical American business, the oil industry is aggressive and competitive both as to product price and quality. This basic fact is not changed by the ending of OPA. Prices of petroleum products, whether gasoline, motor oils, or the multitude of fine products manufactured by the industry, will not be changed because of the ending of the OPA. The petroleum industry, like other sound American industries, will do its best to hold the line on product prices. The industry believes that more production, more efficient distribution, and better products, hold the key to American prosperity.

"Under normal conditions costs vary and prices vary with costs. If we all work together, in due course not only can product prices be held but in many cases they can be reduced as full production and efficient operation are achieved by the effective cooperation of companies, employes, and the public."

● **DRIVES FOR INCREASED WELLHEAD PRICE.** The State of Louisiana has spearheaded a drive designed to bring about a substantial increase in the field price of all natural gas produced in the Southwest area.

The first move made by the state was the adoption of a resolution by the State Legislature urging the Governor "to immediately take such steps as may be necessary in an effort to obtain the full and complete cooperation of the other Southwestern gas producing states with the view of bringing about a substantial increase in the wellhead price of natural gas in the State of Louisiana and the entire Southwest."

On the heels of this action, the Louisiana State Senate Committee on Conservation has acted favorably on another measure, which would authorize the State Conservation Commission to fix minimum field prices for natural gas produced and sold in the state. The commission, under the terms of the proposal, would be empowered to review the prices in the various Louisiana fields from time to time with a view to changing the minimum price in any field. Observers feel that this measure has a better than even chance of being approved.

A company has brought action in Oklahoma to have the authorities in that state take similar action with reference to the Oklahoma natural gas fields.

● **MUST PRESERVE RECORDS, OPA ANNOUNCES.** Manufacturers, wholesalers and retailers, and all other persons required under price control regulations to have kept records must preserve them until July 1, 1947, the Office of Price Administration announced July 2.

The action, Supplementary Order 167, effective as of June 30, 1946, was taken in order to enable OPA to carry on the powers and duties directed to it under the Executive Order 9745 signed by President Truman on June 30, 1946.

The Executive Order authorized OPA to continue all the functions, powers, and duties vested in it by the Emergency Price Control Act of 1942, as amended, and the Stabilization Act of 1942, as amended, which did not terminate by expiration of those acts on June 30, 1946.

OPA pointed out that Section 1 (b) of the Emergency Price Control Act of 1942, as amended, provided that all regulations, orders, price schedules, and requirements shall be treated as remaining in force for the purpose of sustaining any proper suit, action, or prosecution with respect to offenses committed or rights or liabilities incurred on or before June 30, 1946. The July 2 action assures OPA that all records, books, accounts, invoices, sales lists, sales slips, orders, vouchers, contracts, receipts, bills of lading, correspondence, memoranda, or other papers required to be kept under price control will be preserved in keeping with the continuation of its enforcement duties for violations committed before June 30, 1946.

● **API AGRICULTURAL PROGRAM ENDORSED.** Enthusiastic endorsement of the agricultural development program of the American Petroleum Institute was voiced recently by the board of directors of the American Petroleum Institute, at the meeting at Dallas, Texas.

Chairman George Krieger of the Institute's Agricultural Development Committee was instructed to proceed with full dispatch to carry out the research and educational program he outlined to the board.

Briefly, the program contemplates research into the fuller use of farm products, combined with oil products, in the fields of plastics, chemicals, and new materials; the potential use of oil products in increasing soil fertility and the improvement of fungicides, insecticides, and crop ripeners; and the better utilization of oil products in power farming.

Krieger said he had a number of research projects in mind and expected to have the program well under way within a matter of months. Results of API research will be published free of charge to any and all users, he said.

● **ANNUAL MEETING DRILLING CONTRACTORS.** Plans for the sixth annual meeting of the American Association of Oilwell Drilling Contractors are being completed and a record attendance is in prospect, announces Brad Mills, executive vice president. The meeting will be held in San Antonio, Texas, October 1 and 2, and headquarters will be at the Plaza Hotel. The program committee is working to develop a worthwhile list of subjects for presentation. These subjects will be concerned principally with problems confronting the drilling industry. The committee meetings, as usual, will be concerned with association activities and will be designed to invite constructive suggestions from those in attendance. All meetings will be open to the public.

● **SOVIETS TO DRILL 100 WELLS IN NEW AREA.** One hundred new oil wells are to be drilled in Devonian oil strata at the Tuimazy field that Soviet petroleum experts say will be producing 10 per cent of the Soviet Union's total output by 1950. The field, situated between the Volga and the Urals in an area now known as "The Second Baku," was brought into production in 1936. Daily output is nearing 4000 tons. A pipe line is being built to carry the oil from Tuimazy to Ufa, refining center and capital of Bashikria.

● **COMMON RESERVOIR PRINCIPLE APPLIED IN KANSAS.** Modification of basic proration rules for the Otis gas field, Kansas, to extend the common reservoir principle to dry gas wells was announced by the State Corporation Commission.

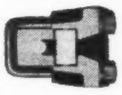
The rules change permits production in excess of allowables from wells agreed upon by a majority of lease owners concerned. To protect correlative rights, the commission ruled, such overproduced gas is to be credited to wells that due to location or physical limitations are unable to put their equitable share of the field's gas into the gathering pipe lines.

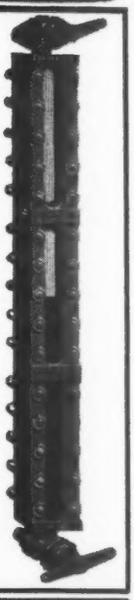
This common reservoir principle previously applied only to combinations wells in the field, producing a surplus of gas in running their oil allowables. The commission's action was on application by Morgan, Flynn and Cobb, Tulsa operators.

PENBERTHY
"REFLEX"
DROP FORGED STEEL
LIQUID LEVEL GAGES

Liquid always shows black—empty space shows white. Preferred where the liquid level must be easily and positively visible, and when liquids are under high pressure or at high temperature. Made of alloy temperature resisting steel and are highest quality throughout. Liquid chamber made from solid block of steel to assure perfect alignment and rigidity. Conform with A.P.I.—A.S.M.E. requirements.

The "Reflex" is one of the complete line of Penberthy Gages that meet every liquid level gage requirement.





PENBERTHY INJECTOR CO.
DETROIT, MICH. Canadian Plant WINDSOR, ONTARIO

PENBERTHY
"REFLEX"
WATER GAGE SET

For oil field, locomotive type and marine boilers. Water shows black — steam shows white; the water level is unmistakable. U-Bolt construction is strongest and simplest to service. Glass replaced by simply removing nuts on face of gage . . . unnecessary to work between gage and boiler. Conforms with A.S.M.E., Federal and State requirements when used for pressures specified by their respective codes.

This is one of the complete line of Penberthy gages that meet every liquid level gage requirement.

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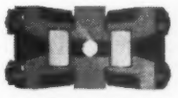
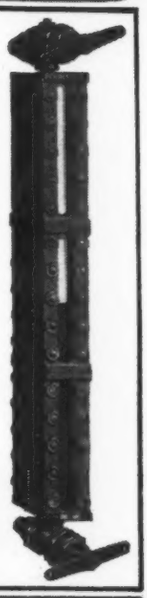
PENBERTHY
"TRANSPARENT"
DROP FORGED STEEL
LIQUID LEVEL GAGES

Used to observe color and density of liquids under high pressures and/or temperatures. Construction exceptionally sturdy. Made of alloy temperature resisting steel, and are highest quality throughout. Liquid chamber made from solid block of steel to assure perfect alignment and rigidity. Conform with A.P.I.—A.S.M.E. requirements.

The "Transparent" is one of the complete line of Penberthy gages that meet every liquid level gage requirement.





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DETROIT, MICH. Canadian Plant WINDSOR, ONTARIO

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SUMP PUMPS

Used wherever seepage water accumulates, the Penberthy Automatic Electric Sump Pump and the Penberthy Automatic Drainer (water or steam operated) have demonstrated their superiority in this service. Simple and rugged design—copper and bronze construction throughout.

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AUTOMATIC
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The accepted method for assuring an uninterrupted supply of feed water to oil field boilers. Penberthy Automatic Injectors will supply feed water to boilers at minimum cost, are quickly and easily installed, reliable under most severe operating conditions, require little attention and no careful handling. Highest quality design and rugged construction.

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Use the power of steam, air or water under pressure to lift liquids. Being simple jet pumps they have no moving parts and require no lubrication. A variety of models to meet different conditions. Also used as water heaters.

PENBERTHY INJECTOR CO.
DETROIT, MICH. Canadian Plant WINDSOR, ONTARIO

MAJOR *Pipe Line* ACTIVITIES

● **EXPAND NATURAL GAS FACILITIES.** Northern Natural Gas Company is planning to construct additions to its pipe line system extending from Texas through Oklahoma, Kansas, Nebraska, Iowa, Minnesota, and South Dakota. The facilities are to increase its line capacity from 270,000,000 cu. ft. to 300,000,000 cu. ft. daily. Estimated cost is $7,886,076. Facilities include: 1. Construction of a 450-hp. gas compressor station near Otis, Kansas, and a 2400-hp. compressor station near Cherokee, Iowa. 2. Installation of two 1000-hp. compressor units at the Sublette, Kansas, station; a 900-hp. compressor unit at the Oakland, Iowa, station; and an 800-hp. compressor unit at the South Sioux City, Nebraska, compressor station. 3. Construction of about 156 miles of 24-in. loop line, about 11½ miles of 20-in. loop line, about 40 miles of 18-in. loop line and about 6½ miles of 12¾-in. line, the latter to connect the South St. Paul and the St. Paul town border stations. 4. Construction of a number of small diameter lines to Webster City, Madrid, Granger, and Grimes, Iowa; Belle Plaine, Jordan, Janesville and Dunnell, Minnesota; and Murdock, Nebraska. 5. Construction of a 2-in. side valve connection with necessary appurtenances on the 18-in. gas transmission line as well as a measuring and regulating station in the vicinity of Mynard, Nebraska.

● **TEXAS PIPE LINE.** A petroleum products line system that will link Hearne, Dallas, Fort Worth, Austin, and San Antonio is being planned by The Texas Pipe Line Company. Field construction is not expected to get under way until early 1947. A 10-in. line will be built from Hearne to either Fort Worth or Dallas. A 6-in. line then will be laid to the other city not chosen as the terminal for the main line. An 8-in. line will be constructed from Hearne to Austin and a 6-in. line from Austin to San Antonio.

● **NEW GAS OUTLET.** Cities Service Gas Company has been granted authority by the FPC to begin construction August 1 on 64½ miles of 12-in. natural gas pipe line from the West Edmond field to the Drumright compressor station. The company was also granted permission to construct 6¼ miles of 16-in. line from the Craig Storage field. Cost of the two projects was estimated at $1,075,000 and completion is expected by November. The new lines will increase the capacity of facilities for taking West Edmond gas to an estimated 60,500,000 cu. ft. daily, an increase of 27,500,000 ft.

● **"L SYSTEM" OPERATION CONTINUED.** Arkansas Louisiana Gas Company, Shreveport, Louisiana, has been authorized by FPC to continue operation of its "L System" that was constructed under contract with Defense Plant Corporation to serve gas to Arkansas war plants. The system includes about 91 miles of 18-in. pipe line extending from a gasoline extraction and desulphurization plant owned by Arkansas Fuel Oil Company in Columbia County, Arkansas, to the applicant's Perla regulating station in Hot Springs County; about 9 miles of 12¾-in. pipe line extending from the Perla Station to Jones Mills; 22 miles of 12¾-in. pipe line from Perla Station to Bauxite Junction; and about 21 miles of 10¾-in. and 12¾-in. loop line between the Perla Station and Bauxite Junction. Permission has also been granted to add to the "L System" new facilities consisting of about 16 miles of 12¾-in. connecting pipe line extending from Bauxite Junction to Little Rock, Arkansas; about 5 miles of 12¾-in. pipe beginning on the first line and continuing with 4 miles of 8⅝-in. pipe to the site of the Lynch Power Plant now under construction by Arkansas Power and Light Company at Rose City near North Little Rock, Arkansas. Construction costs are estimated at $530,391.

● **HEARING DATE SET.** August 1 has been set by FPC for the hearing on the application of Washington Gas Light Company for authorization to construct and operate a 16-in. pipe line to supply gas to Rosslyn Gas Company for resale in Arlington and Fairfax Counties and Alexandria, Virginia. The proposed line will begin at Washington Gas Light's West Station gas manufacturing plant at 26th and G Streets, N.W., and connect with an existing 12-in. line at the North of Key Bridge. Cost is estimated at $90,000.

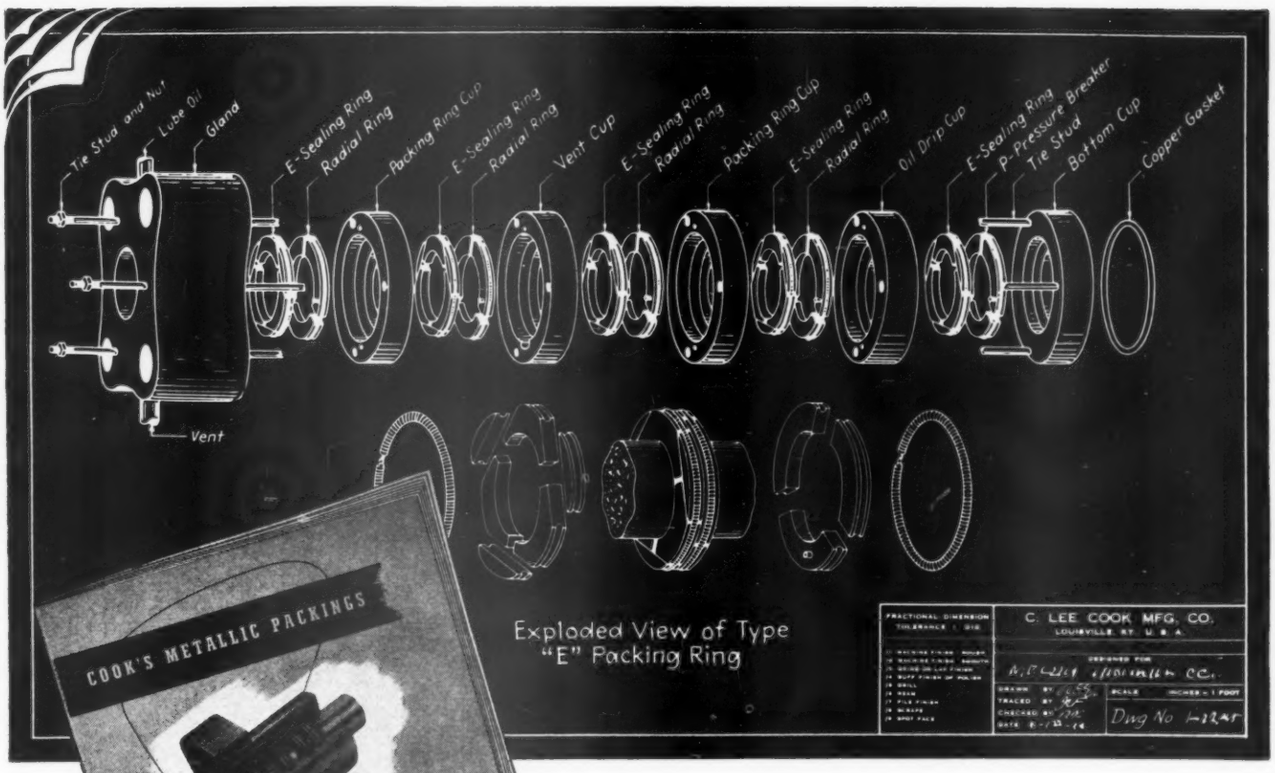
● **PROPOSED PIPE LINE ADDITIONS.** United Gas Pipe Line Company, Shreveport, Louisiana, has filed application with FPC for permission to construct additions to its pipe line system. Permission has been requested to extend the company's pipe line system in Mississippi to connect Baxterville and Gwinville fields. The Baxterville extension will require about 10 miles of 12¾-in. line and the Gwinville extension 13½ miles of 10¾-in. line. Estimated cost of the Baxterville line is $281,696 and of the Gwinville line $263,018. The company also proposed to construct a 3-mile extension to its Laurel loop, using 12¾-in. pipe, at a cost of $62,461. Louisiana facilities proposed are an extension of about 16½ miles of 12¾-in. pipe to Hayes gas field. Estimated cost is $635,405. Request is also made to construct and operate an extension of about 1 mile of 2-in. pipe line from its line to the vicinity of Richton, Mississippi.

● **EXPORT GAS TO MEXICO.** The Reynosa Pipe Line Company, a Texas corporation, has been authorized by FPC to export and sell up to 50,000,000 cu. ft. of natural gas per day to Gas Industrial de Monterrey, S.A., a Mexican corporation. The authorization is contingent upon the filing of an application with the commission for authorization to construct approximately 30 miles of pipe line from Hidalgo County, Texas, gas fields to the Mexican border.

Authorization has been granted to the United Gas Pipe Line Company to continue exportation of natural gas from the United States to the Republic of Mexico under a revised contract with Compania Mexicana de Gas, S. A.

● **ADDITIONS TO TEXAS-MICHIGAN SYSTEM.** Panhandle Eastern Pipe Line Company has been authorized by FPC to construct and operate the following facilities: 1. A field compressor station, located near Sunray, Moore County, Texas. It will have a capacity of 3000 hp. and will include a dehydration plant. 2. Additional compressor units of 800 hp. to be installed in existing compressor stations as follows: Three at the Hansford compressor station in Hansford County, Texas; two at the Hugoton compressor station in Stevens County, Kansas; and one at the Olpe compressor station in Lyon County, Kansas. 3. Two 1600-hp. compressor units to be installed in each of these stations: the Glenarm compressor station in Sangamon County, Illinois; Tuscola compressor station in Douglas County, Illinois; Zionsville compressor station in Marion County, Indiana; and Edgerton compressor station in Allen County, Indiana. 4. Fifty miles of 18-in. trunk line extending from the vicinity of Shamrock Oil and Gas Company's natural gas processing plant in Moore County, Texas, to the Hansford compressor station, and 24 miles of 26-in. loop line extending from the outlet side of the Tuscola compressor station paralleling existing loop lines. 5. Compressor cylinder and valve changes on equipment and piping at the Liberal compressor station, Seward County, Kansas.

● **SEEK AUTHORITY TO CONSTRUCT CARRIER.** Virginia Gas Transmission Corporation, Charleston, West Virginia, has made application to FPC for authority to construct and operate a lateral pipe line to sell and deliver natural gas for resale in Lynchburg, Virginia. The company also proposes to reinforce transmission facilities through which it delivers gas to Atlantic Seaboard Corporation to supply Washington Gas Light Company. The proposed facilities include a new 1600-hp. compressor station in Greene County, Virginia, and the installation of an additional 800-hp. compressor unit at its Gala compressor station, Gala, Virginia, plus a 30-mile 6-in. lateral line extending from a point on the main transmission line near Lexington, Virginia, to the vicinity of Lynchburg. Estmated cost is $900,000.



SIMPLE AS ITS INDIVIDUAL PARTS

THE PISTON RODS of your gas engine driven compressor are probably fitted with Cook Metallic Rod Packing—in which case you are familiar with the construction of Cook Packing and appreciate that it is *as simple as its individual parts.*

The uninitiated, too, will appreciate this fact from a brief consideration of the "exploded" drawings above. Note that the assembly consists simply of a gland, a series of cups and packing rings, all securely held together and aligned by tie studs. The number of rings and the ring material—iron, bronze or Bakelite—is determined by the service requirements.

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MAJOR *Oil Field* ACTIVITIES

● **KANSAS.** Mazda Oil Company and Bennett and Roberts No. 1 Henderson, CEL SE NE 22-11-18w, has opened a new pool in Ellis County. The well averaged approximately 30 bbl. of oil an hr. swabbing from the Arbuckle.

Skelly Oil Company is making additional tests at its prospective pool opener Boggs No. C-1, SW NE NE 17-33-12w, more than a mile east of production in the Medicine Lodge pool. The well flowed 13 bbl. of oil in 10 hr. from 4816 ft. in the Simpson formation.

Brack and Huber No. 1 Rutherford, SW NE NW 8-20-16w, about 10 miles north of Pawnee, has appearances of being an Arbuckle lime discovery. The Arbuckle was topped at 3815 ft. A drillstem test was taken from 3816 23 ft. and the tool was open for 30 min. When the drill pipe was withdrawn, some 1260 ft. of oil accompanied it.

Republic Natural Gas Company No. 1 Hille, SE SE SW 23-15-24w, Trigo County, has opened a new oil pool. In a 6 hr. swabbing test from the Mississippi at 4293-316 ft., the well produced 39 bbl. of oil.

Rush County may have another oil pool at Keys Drilling Company No. 1 Dwyer, SW SW 1 19-18w, nearly two miles south of the Albert pool. Good saturation and porosity was logged in the Arbuckle lime at 3625-32 ft.

Isern Brothers No. 3 Southern, SE SW NE 14-19 10w, Rush County, has opened the Doran West-Kansas City lime pool. It was assigned a minimum well rating to open a new horizon in an area already productive from Arbuckle lime.

● **WYOMING.** A good showing of oil in Wasatch Oil Refining Company and associates test well in the southwest quarter of 13 26 89, several miles east of Bailey Dome, north of Rawlins, indicates a new oil pool. The well was drilled to a total depth of 6972 ft. and the hole filled with 30-gravity oil.

● **TEXAS.** Garza County may have a wildcat strike that will open a new sector at Northern Ordnance No. 1 Walker, 45-6-H&GN, 7 miles southeast of the Garza pool. A 40 min. test was run at 2400-75 ft. in the San Andres and recovered 700 ft. of mud with the bottom 10 ft. slightly oil-cut.

Continental Oil Company No. 1-G Garcia opened a new pool for Starr County. The well produced the equivalent of 103.2 bbl. daily on flow valves through 48 perforations at 3592 9 ft.

Young County may have two new producing pools southeast of Olney. A. R. Dillard and Associates No. 1 Marietta Killian, 211-TE&L, reached the Mississippian at 4949 ft. and logged saturation to 4966 ft. On a test there was a show of gas and oil.

Two miles southeast of the Dillard strike, Robert C. Davis No. 1 Baldwin Lovett, 207-TE&L, topped saturated Caddo lime at 4117 ft.

Tom Graham, Corpus Christi operator, has opened a new gas-condensate field in Brooks County at his Mauro Chavana No. 1, 3½ miles southwest of Alta Mesa field. The well showed both gas and condensate on drillstem test at 7303-7309 ft.

A new gas pool has been opened at Continental Oil Company No. 1 Heath in Jack County. The discovery gauged 1,070,000 cu. ft. of gas a day from the Bend conglomerate at 4431-55 ft.

Roeser and Pendleton No. 1 T. W. Lee, 27-11-T&P, has opened a new Caddo lime pool for Shackleford County, 2 miles southwest of Albany. The well was rated as good for 200 bbl. a day from a depth of 4463 ft.

A new Canyon lime pool has been opened southeast of Vernon in Wilbarger County at National Associated Petroleum Company No. 1 Schmoker. The well flowed 323 bbl. of oil a day. The Canyon lime was reached at 3500 ft.

There are prospects of Floyd Karsten No. 1 Menke, 2 miles southwest of Hempstead in Waller County, opening a new oil pool. Sections at 9700 900 ft. indicated possibilities on electrical log test.

Wayne County may have a new oil pool at Deep Rock Oil Corporation No. 1 Ulysses (U. S. Spicer), NE NW NW 30-1n-6e, about 2 miles west of the Johnsonville oil pool. The well showed a recovery of gas in 14 min. and flowed clean oil in an hour from the McClocky limestone. Total depth is 3159 ft.

The Texas Company No. 1-P University, 15-12-U, appears to be opening a new Permian Clear Fork line pool for the western sector of Andrews County. On a 2-hr. drillstem test at 7127-269 ft. gas appeared in 13 min.

Cooper Gas Company No. 1-A Koy is expected to open a pool in the Permian Basin. The well is located on the Jess Koy ranch in Schleicher County. It is rated as a 100-bbl. an hr. discovery from the Strawn lime at 5350-410 ft.

● **LOUISIANA.** Three parishes in the southern part of the State have prospects of new oil pools. In the Bilbo area of Beauregard Parish, Magnolia No. 1 Powell Lumber, 17-6s-11w, 2 miles northwest of the Oretta pool, ran production test from perforations at 8414-22 ft. in the Cockfield.

Avoyelles Oil No. 1 Bordelon, 56 2n-4e, in the Avoyelles Prairie area of Avoyelles Parish, was tested from 7931-49 ft. in a Wilcox sand that showed good saturation. The wildcat is 20 miles northeast of Eola.

Jefferson Parish has a prospective pool at California Company No. 4 Brady, 19 16s.24e, in the Alliance area, south of the Bayou la Fleur pool. The well was cemented at 1201 ft. and preparations were made to perforate. The test is credited with several oil shows.

There are indications of a new gas pool in DeSoto Parish at Kerr-McGee Oil Industries, Inc., No. 1 Nabors, C SW SE 28-12n-14w, west and south of Mansfield. On drillstem test of the lower Pettit zone at 6176 88 ft., the wildcat showed gas immediately and pressure built up to 400 lb. in nine min.

● **COLOMBIA.** The Texas Company's first exploratory well in Colombia has struck oil sands of sufficiently high quality to indicate a new field. The well is 7461 ft. deep and is on land wholly owned by The Texas Company in Boyaca.

● **OKLAHOMA.** McClain County has indications of a new pool at Big Chief Drilling Company No. 1 Stephens, C SE SW 25-5n-2w, southwest of Wayne. The well had a soft Pennsylvania sand at 6538-41 ft., a hard streak at 6541-43 ft., and a soft streak at 6543-53 ft. On 20-min. test an estimated 4,000,000 cu. ft. of gas was recovered and 60 ft. of condensate.

Wilcox Oil Company has discovered a new gas pool at No. 1 Callahan, SE SE NE 24-12-9e. The well reached the Hunton lime at 3668-98 ft. and on a test produced at the rate of 14,000,000 cu. ft. of gas a day.

Fred Morgan No. 1 Cash, NE NE SW 6-14-4e, has opened a new oil pool in Lincoln County, north of the Chandler pool. From the Skinner sand at 4210-20 ft. the well produced 5 bbl. of oil an hr. and from the Oswego at 3918-28 ft. flowed 10 to 12 bbl. an hr. Gas production was estimated at 1,500,000 cu. ft. a day.

A new field in Cotton County is indicated at R. B. Farris No. 1 Indian, NW NW SW 1-4s-11w. The well is bottomed in sand at 1500 ft. and pumping equipment is being installed for the initial test.

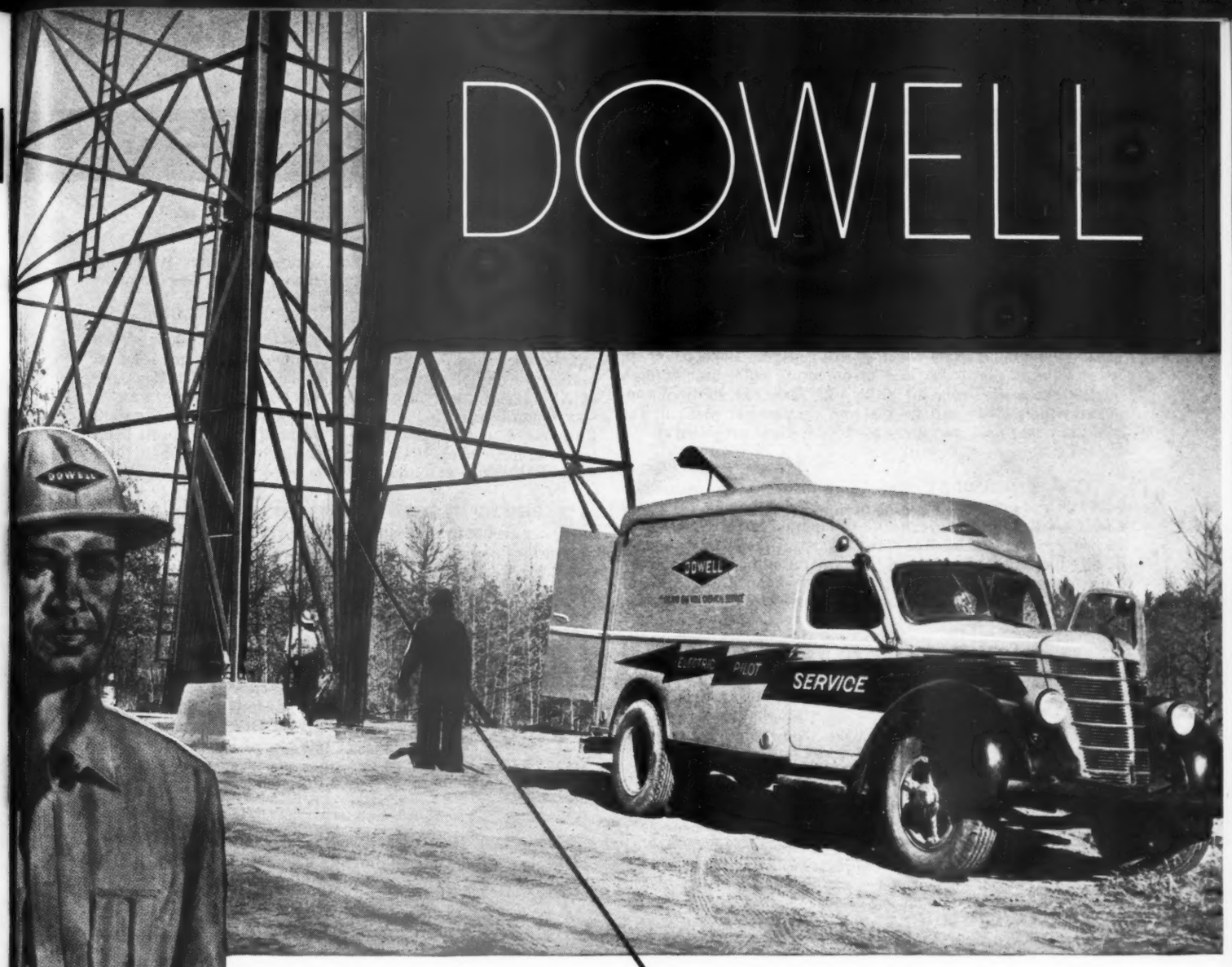
Garvin County has a new oil pool at Cities Service Oil Company No. 1-B Wallace, NW NW SW 18-3n-1w. The first Bromide was found at 5312-27 ft. and on the drillstem test the well made 30 to 35 bbl. of oil an hr. with 2,000,000 cu. ft. of gas.

Tom Berry No. 1 Johnson, NW NW SW 27-6-3e, opened a shallow oil pool in the south end of Pottawatomie County. The well showed 150 bbl. of oil and 50 bbl. of water in the shallow producing horizon. Sand was from 1840-55 ft.

A promising shallow gas field has been opened in Okfuskee County by George C. Vincent and Wade Allen at Vincent-Allen No. 1, C NE SE, 17-21-11. The well gauged 3,500,000 cu. ft. of gas from the Calvin sand.

A new pool looms in Garfield County at J. E. Crosbie, Inc., and Warren Petroleum Corporation No. 1 Seigle, NE SE SW, 32-23-4w. On a test at 6048-60 ft., 30 ft. of high gravity oil and 90 ft. of oil and gas-cut mud were recovered.

DOWELL



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MAJOR *Refining* ACTIVITIES

● **STANOLIND NATURAL GAS PLANT.** Stanolind Oil and Gas Company is planning construction of a plant in southwestern Kansas to manufacture automotive gasoline and other products from natural gas. Operating on the Fischer-Tropsch process, the Stanolind plant will transform the natural gas into liquid gasoline and condensate fuels. It will consume 100,000,000 cu. ft. of natural gas a day and manufacture 6000 bbl. of high quality automotive gasoline a day plus 1000 bbl. daily of condensate fuels. This will be the first commercial plant in the Mid-Continent area and the second such plant projected in the United States.

● **NEW EQUIPMENT.** New units costing approximately $450,000 and principally for the production of asphalt, are being added to British American Oil Company, Ltd., refineries at Moose Jaw, Saskatchewan, and Calgary, Altamont. A vacuum distillation unit is expected to be in operation in both plants by the early part of next year. Each unit will be a conventional vacuum distillation unit and, with accessories, will cost approximately $200,000.

● **ARKANSAS CRACKING UNIT.** The purchase of the only catalytic gasoline cracking plant in Arkansas is being sought by Root Petroleum Company at Shreveport, Louisiana. The company is negotiating with RFC for the plant that Root operated during the war, manufacturing 100-octane gasoline. Company officials stated that if the company obtained the property, it would be remodeled and used to produce an extra premium high octane gasoline.

● **REFINERY FIRE.** Standard Oil Company (Indiana) plant at Whiting, Indiana, suffered $150,000 damages from fire. A block-long oil storage and barrel-filling building was destroyed but the fire was brought under control before it could reach surrounding structures.

● **PURCHASE PLANT.** Blue Diamond Oil Refinery, Beaumont, Texas, has purchased the Jordan Oil Company refinery at Huntington. The new owners renovated the refinery and have placed it in operation. The plant now is producing about 1000 gal. daily of high grade lubricating oils and the output will be increased shortly.

● **McCARTHY CYCLING PLANT.** McCarthy Oil and Gas Corporation is planning the construction of a $10,000,000 cycling plant for the Blue Lake pool of Brazoria County. The proposed plant would have a capacity of 300,000,000 to 400,000,000 cu. ft. of gas-condensate a day. It is reported that plans for the plant hinge on the cooperation of Brazoria County officials in the construction of highways to the pool and of landowners in unitization of acreage.

● **REFINERY ON STREAM.** Rogers Lacy's new refinery at Big Sandy, Texas, has begun production of gasoline. When capacity is reached, the plant will process 3500 bbl. of crude daily.

● **PLANT ADDITIONS.** Baird Refining Company's refinery at Baird, Texas, has undergone improvements that will increase the refinery's capacity from 1800 bbl. to 2500 bbl. a day. The work includes the installation of a new stabilizer and additional storage.

● **ENLARGE WEST EDMOND PLANTS.** Phillips Petroleum Company and Continental Oil Company have approved expenditures of $2,700,000 for enlarging their plant and gathering systems in the old Edmond field. Some work is now underway and it is expected equipment will be available and installed by late summer.

Peppers Refining Company has ordered equipment to enlarge its plant in the West Edmond field, to increase its capacity to 20,000,000 cu. ft. a day. The plant is now processing 10,000,000 to 12,000,000 cu. ft. a day, with Oklahoma Natural Gas Company taking most of the residue.

● **POLYMERIZATION UNIT SETS RECORD.** A long record run of more than four years continuous operation has been established by a polymerization unit at the Standard Oil Company of New Jersey plant in Linden, New Jersey. The unit was designed and constructed jointly by the Standard Oil Development Corporation and Foster-Wheeler Corporation. It began its long-term run in October, 1941, which was halted in November, 1945, when 100-octane gasoline contracts were cancelled.

● **REFINERY RESUMES OPERATIONS.** The petroleum refinery situated at Pernis near Rotterdam, in the Netherlands, has resumed operations. Although 25 storage tanks, 70 working tanks, 115 pumps, and 280 electric motors were destroyed or removed, and considerable other damage was done during the war, storage capacity of 465,000 cu. meters has been restored. Prewar storage capacity was 745,000 cu. meters.

● **PLANT IN OPERATION.** The 15,000,000-ft. per day natural gasoline plant in the Emperor field of Winkler County belonging to C. V. Lyman, Midland, Texas, is now in operation. A portion of the residue gas will be used for repressuring adjacent leases and the remainder will go into the El Paso Natural Gas Company pipe line. Natural gasoline produced will be sold to Standard Oil Company of Texas for delivery to its El Paso refinery.

● **REFINERY HEADQUARTERS BUILDING.** Standard Oil Company (Indiana) is planning construction of a new headquarters building for the Whiting, Indiana, refinery. The building will house the administration, engineering, and engineering research staffs of the refinery. It will be in Hammond, close to the 1000-acre refinery in adjacent Whiting and immediately north of the Standard of Indiana research center now under construction.

● **COMPLETE CRACKING UNIT.** The Texas Company's new fluid catalytic cracking unit at the Lockport, Illinois, refinery has been completed. This unit is equipped with the largest fractionating tower ever used on a catalytic cracker. It is now turning out 13,000 bbl. of gasoline per day and, according to the company, the output should be 20,000 bbl. per day at the year's end. The unit has a height of a 12-story building and requires the full time of 52 men solely for operating purposes.

● **UNIT TREBLES OUTPUT.** The Texas Company's alkylation unit at Port Arthur, Texas, has produced alkylate at the daily rate of 85,840 gal. since 1939. The unit was originally designed for 30,000 gal. a day and is now producing in excess of 120,000 gal. a day. This unit was the first of five alkylation units and has set an outstanding 7-year record of 219,340,000 gal. to meet the fabulous wartime demands for high octane aviation fuels.

● **TWO NEW PLANTS.** Shell Chemical Corporation is building two new plants at Houston, Texas, for the first commercial production of glycerin epichlorohydrin, a petroleum chemical. The addition of the new units will also increase Shell's production of isopropyl alcohol by 100,000,000 lb. a year. The plants are being built adjacent to Shell's Deer Park refinery at an approximate cost of $3,000,000. C. F. Braun and Company and Fluor Corporation, Ltd., are contractors for the project.

● **NEW TREATER.** Old Dutch Refining Company now has a new Unisol treater in operation at its plant in Muskegon, Michigan. The treater was built with refinery labor at a cost of about $36,000. Capacity of the unit is about 1500 bbl. daily.

THE Petroleum Engineer

JULY, 1946

Looping increases line capacity

FRANK H. LOVE, *Managing Editor*

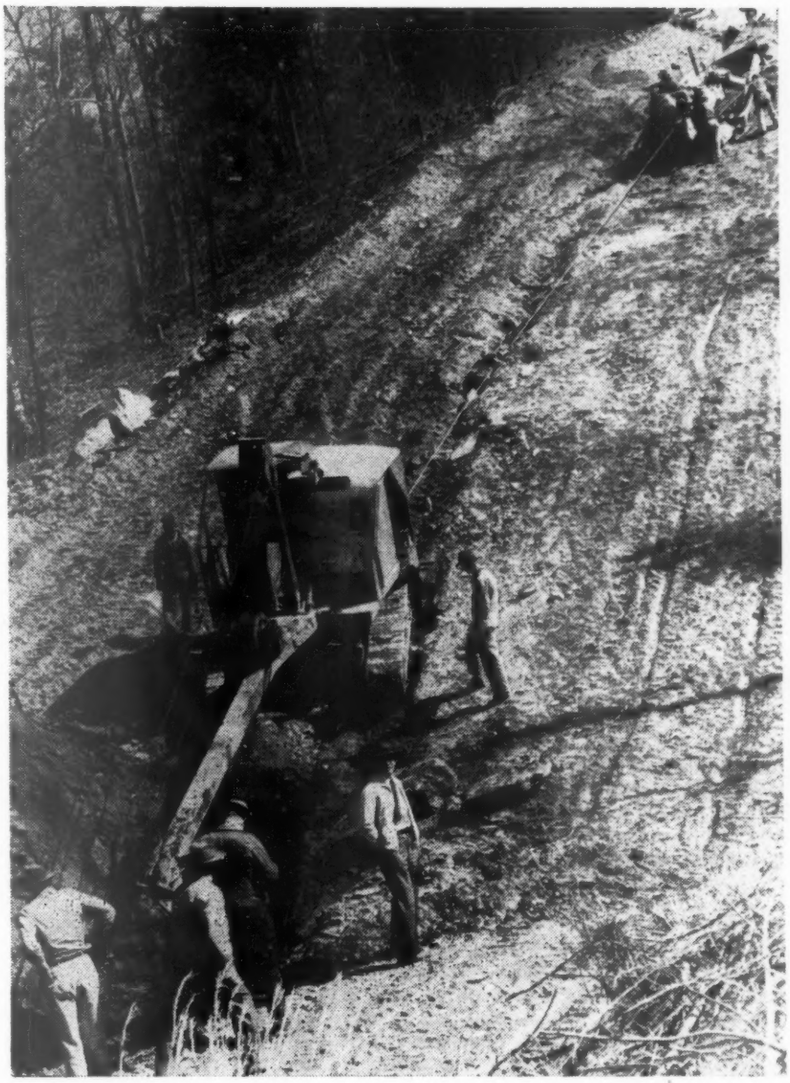
Now in operation by Southern Natural Gas Company are eight loops to its pipe line system recently completed in the states of Alabama, Georgia and Mississippi. These additions, details of which are given in Table 1, have increased line capacity by approximately 20,000,000 cu. ft. a day.

EXCLUSIVE

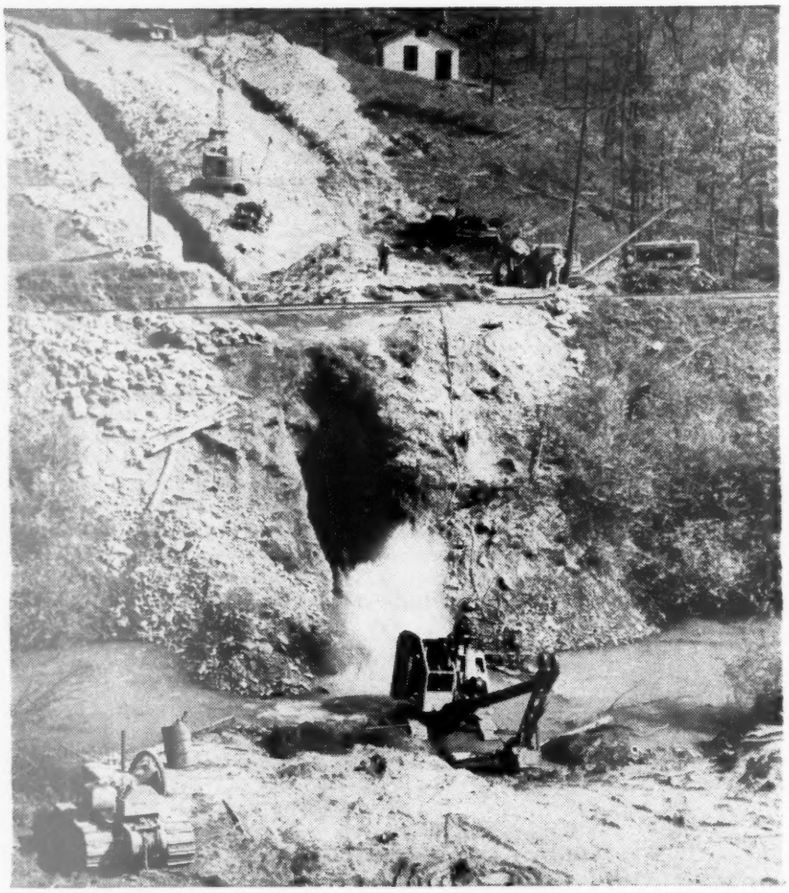
Highlighting the project from the construction viewpoint was the excessive rainfall during the time the work was in progress, which enhanced manyfold the difficulties encountered, particularly since the loops were laid almost entirely in swampy areas that even under so-called normal conditions present virtually insurmountable problems. Official figures of the U. S. Weathr Bureau reveal that the average rainfall for the four months of December, January, February, and March was 9 in. a month, as against a normal 6 in. a month, an excess of about 65 per cent. This was the heaviest rainfall since the year 1854.

The right-of-way, more often than not, was a virtual sea of mud and water and to keep the heavy equipment from sinking out of sight it was necessary to build bridge-ways and corduroy roads. Through such areas the ditch could be made only with draglines operating off the bridge-ways, and the liberal use of pumps was required to keep it drained of water and mud.

Other than the problems involved in the construction of the line, the project assumed importance to the pipe-line industry in that for the first time a full-time safety engineer was employed. Frank Scott was borrowed by the contractor from the Southern Natural for the job and the safety program instituted was extensive in scope. Safety meetings were held once a week at which "on the job accidents" and safe practices were discussed. Movies on safety were shown at these meetings also, to bring home to



Winch-line tractor holds backhoe on steep hill while digging trench.



This tunnel through solid granite 22 ft. under railroad tracks was blasted by coal miners who are adept at the art.

the workmen in a forceful manner the value of following a program of safety, as well as to instruct in safe methods.

Inasmuch as this was something new for pipe-line construction crews. Scott inaugurated a contest between the different spreads to attract interest. War Bonds were offered as prizes to the winning spread superintendent and to each of his gang foremen. The winners in the contest were determined on the basis of manhours exposure as compared with lost time accidents. Weekly standings of the various spreads were posted in the field offices.

Results of the safety program were highly gratifying. The number of accidents was materially reduced, and, in addition, the industry was provided certain data of value. Detailed tabulation showed in what types of work accidents were most frequent. In this respect it cleared up a few preconceived notions, at least insofar as this job was concerned. For example, it seems to be most generally thought that more accidents occur in the dope gang than in any other. Experience on the Southern Natural job revealed that this was not the case. The greatest number of accidents was in the pipe or "laying" gang, as a matter of fact, with the painting or "dope" gang and the ditching gang tied for second place. The tabulation of where the accidents occurred and their frequency are given in Table 2.

When final results of the War Bond contest were determined, it was found that Gang No. 1 under the supervision of Elwood Roth was the winner with a frequency average of 45 accidents per million man-hours worked. In second place was Gang No. 2 under Bob Shivel with a frequency average of 48.5 accidents per million man-hours. Spread No. 3 under Bennie Williams was third with a frequency average of 67.3 accidents per million man-hours worked.

Frequency average for the job was 50.5 accidents per million man-hours worked. The industry frequency average for gas utility construction is 38.12.

Of especial interest is the "days lost" record: Gang No. 2, 158 days; Gang No. 1, 178 days, and Gang No. 3, 180 days—total 512 days, giving a total severity average of 0.565. The industry severity average is 2.32.

Construction procedure. Three gangs were employed in performance of the work. Gang No. 1 laid two 20 in. loops near Atlanta, Georgia, and one 20-in. loop near Leeds, Alabama.

Gang No. 2 constructed a section consisting of a 12-in. loop, a 22-in. loop, and a multiple river crossing at the Warrior River, all near Tuscaloosa, Alabama.

Gang No. 3 laid a 22 in. loop and a multiple river crossing at the Tombigbee River near Columbus, a 22 in. loop near Kosciusko, and a 6-in. loop near Meridian, all in Mississippi.

Because of the nature of the terrain it was necessary to lay the loops entirely by the stove-pipe method. The weight of the 22-in. pipe was 65.24 lb. per linear ft., and its wall thickness was 9/32 in. The 20-in. pipe, with a wall thickness of ¼ in., weighed 52.73 lb. per ft. The 12-in. pipe used in river crossings had a wall thickness of ⅜ in. and weighed 49.56 lb. per ft., whereas regular 12 in. line pipe had a wall thickness of ¼ in. and weighed 33.38 lb. per ft. The 8-in. pipe weighed 22.36 lb. per ft. and had a wall thickness of ¼ in.

A typical rather than an unusual scene along the right-of-way. Mud, muck, and water everywhere.

Above—A rocky hillside that had to be blasted. *Below*—Coming out of low country into mountains.

After fighting miles of swamps and lowlands it was a great relief to work in mountain country near Tuscaloosa, Ala.

The 20 and 22-in. pipe were of combination welded and coupled construction. All joints of the 8 and 12-in. pipe were welded. On pipe having $\frac{3}{8}$-in. wall thickness five beads were run and on pipe of $\frac{1}{4}$-in. wall thickness, three beads.

As a part of the construction work, three river crosings were laid. Across the Tombigbee River at a point near Columbus, Mississippi, three 12-in. lines were installed. This pipe had a wall thickness of $\frac{3}{8}$ in. The length of the crossing from header-to-header was 1100 ft., although the river channel is only about 400 ft. wide. Each string of pipe was welded on shore, coated with a 3/32-in. thickness of hot enamel, weighted with 1500-lb. cast-iron clamps, and pulled into place. The pipe was buried in the banks only and on the bed of the river was given upstream slack.

TABLE 1. Loops laid by Southern Natural Gas Company.

Location	Pipe size, in.	Length of loop, mi.
Dog River	20	7.6073
Ben Hill	20	4.5685
Trussville	20	5.4924
Tuscaloosa	12	13.217
McConnell-Warrior	22	20.6322
Warrior River	22	0.625
Tombigbee	22	9.5263
Tombigbee River	22	1.3636
Zama	22	13.570
Meridian	6	9.5494

TABLE 2. Tabulation of accidents showing where they occurred most frequently.

Location	Clearing	Grading	Ditching	Stringing	Laying	Welding	Painting	Lowering-in	Cleanup	Total
Douglasville	4	3	10	1	5	1	6	2	1	33
Tuscaloosa	2	0	5	1	13	2	7	4	0	34
Columbus	2	1	10	1	13	1	12	2	0	42
Total	8	4	25	3	31	4	25	8	1	109

The North River crossing, in Alabama, was originally scheduled for three 12-in. lines the same as the Tombigbee and Warrior; however, the final decision was to lay a single 22-in. line. The channel here was only 175 ft. and a ditch was blasted in the rock bottom of the river to bury the pipe.

● **General office facilities.** General office facilities for the contractor were of an unusual nature. They were situated at the Municipal airport at Tuscaloosa, Alabama, in buildings constructed during the war by the U. S. Army for administrative purposes and which subsequently had been turned over to the city of Tuscaloosa. The large office building adjoined an airplane hangar, thus the contractor's offices and twin-engine plane, which was used to transport personnel and to fly in critical parts to the job, were housed under the same roof.

In addition to the offices, other buildings that had been used by the Army to house its officer personnel were converted into apartments and bedrooms.

● **Contractors and engineers.** The general contractor for the construction work was the H. C. Price Company of Bartlesville, Oklahoma, of which H. C. Price is president and J. P. Neill general superintendent. C. S. LeNoir was general superintendent of this project and in charge of all field construction work. A. M. Wimberly was office manager in charge of accounting and auditing.

Ford, Bacon and Davis Construction Corporation served as engineers for the project under the direction of C. C. Whittelsey, vice president. A stretch of five miles through Coal Fire Swamp was left for the latter firm to lay after the rest of the loops had been put into operation and the general contractor had moved out. This was necessary because the swamp, normally dry, was completely under water at the time the rest of the work was done. ★★★

The drips problem

By **JULIAN A. CAMPBELL**

Research and Development Engineer

THE method employed by a natural gasoline company in handling the drips in its gas gathering system, sometimes spells the difference between a profit and loss. Many a capable superintendent has charge of a large network of lines with the laying out of which he had nothing to do. He inherited a headache. Many of the systems in the early days of frantic field development were not planned at all. They just grew like Topsy. Lines were put in that were too small and no provision was made for putting in drippots in the sags; however, an engineer who knows how to go about it can work wonders with such a system if he is permitted to spend a little money. His first step is to make a pressure survey. He puts recording pressure gauges at various points on the system and, knowing the size of each line and knowing how much gas is passing through, he knows what the pressure drop between any two points should be. If this drop is greater than the theoretical, he begins looking for a liquid block. As he locates these, he will install drips where they occur and provide means for periodically emptying them. This is usually done by employing a tank truck equipped with a vacuum pump. In making his survey, he will often find that by tying two lines together he can relieve a bad pressure condition. Often by putting more gas through a line you can actually lower the pressure drop by sweeping slight swales in the line free of liquid. Quite often you can reduce pressure on the terminal wells by "looping" lines, giving the gas a choice in its route to the plant.

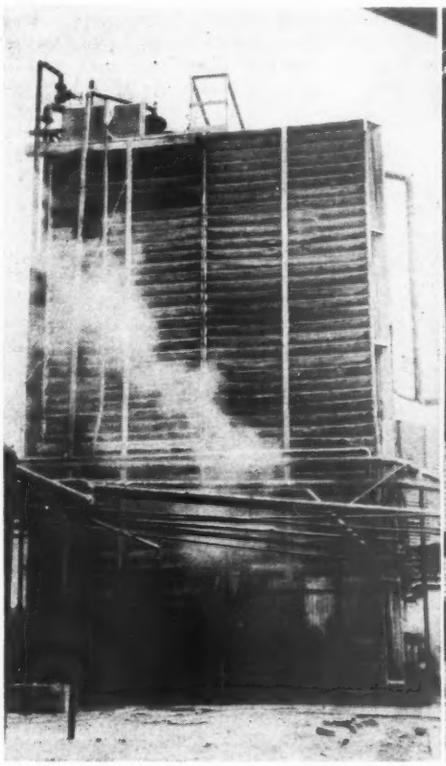
EXCLUSIVE

In closely drilled fields there are often several systems belonging to different companies and the wells are drilled so close together that the system that maintains the highest vacuum gets more of the gas. Sometimes when one company has a well far out on its system but which is close to the plant of another company, it will make arrangements with that company to treat the gas. More of this could be done to mutual advantage.

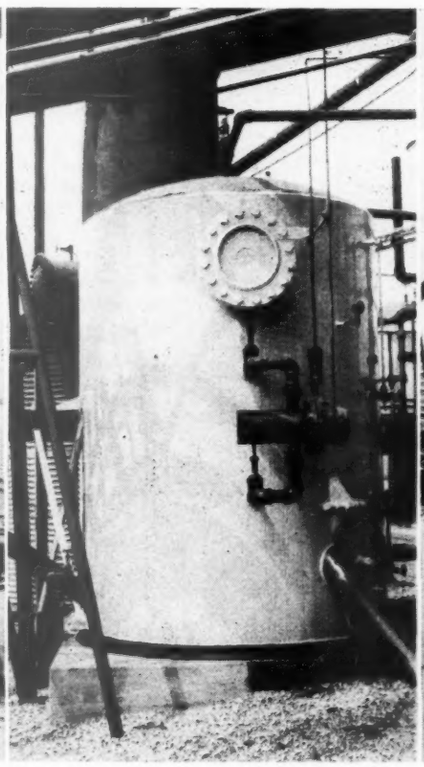
The big problem in operating the system is to maintain as high a vacuum as possible on your terminal wells. Any liquid block in the line between these wells and the plant will cause a lowering of the terminal vacuum and possibly a building up of a positive pressure.

Some years ago I worked out a plan for handling the drips situation for a large plant on Signal Hill that has been in effect ever since and has proved very profitable. Every well on the system has, of course, its own recording gas meter. The charts from these meters are gathered each morning by the "chart pluckers." Those from the meters on the terminal wells are put in a separate container and on reaching the plant, are turned over to the graph recorder. This gentleman records the pressure shown on these charts in its proper place on a large wall chart made of cross-section paper and marked off for a whole year by months and days. We will say that Taylor No. 3 normally shows five inches of vacuum. Then we will look for Taylor No. 3 printed on the extreme left end of the long chart just above one of the heavy cross-section lines, and we will observe that this line is marked five inches. The first light line above this is four inches then three inches, two inches, one inch and zero. The first line below would be six inches. This particular system has about 30 of these terminal or key wells as we call them. The pressure on each of them is recorded each day opposite the name of

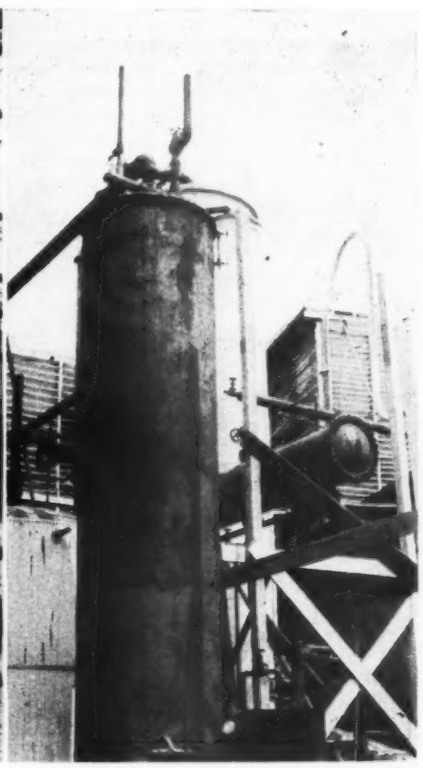
Cooling tower containing condenser coils for evaporated drips. Dephlegmator is open box type on top of tower.



Reflux tank. As dephlegmator is on top of cooling tower, reflux flows by gravity to wash section of evaporator.



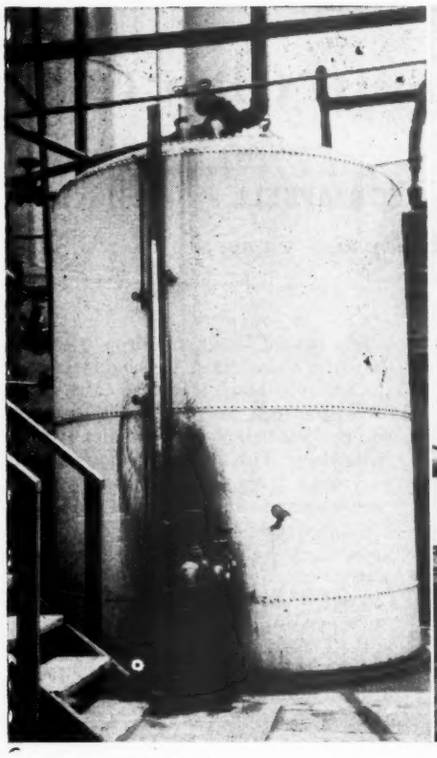
Drips evaporator with elevated preheater so that condensed steam returns to boilers by gravity.



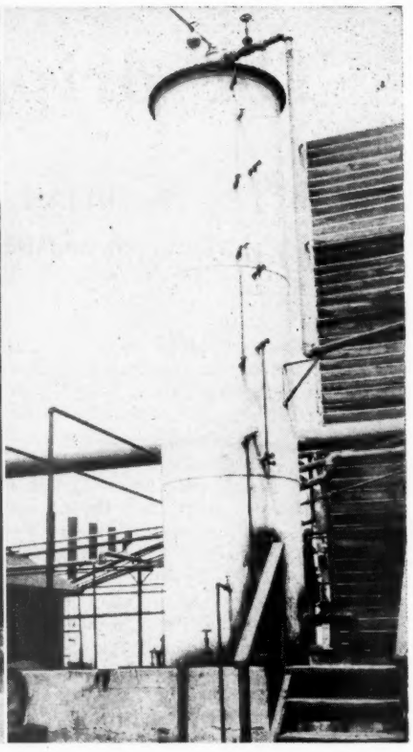
the well by making a dot on the proper line and then connecting this dot with the dot placed the day before by a line. The result is an irregular line with its ups and downs and the object of the game is to eliminate these, especially the "ups" and keep the line approximately straight and on the level.

When the pressure on Taylor No. 3 rises two points to three inches vacuum, it is recorded in red ink and similarly for all the other wells. This record is completed at a certain time each morning and then the driver of the drips truck comes in with his notebook and notes the red peaks. He visits the worst ones first and pumps the drips on these lines, taking care of the others later.

Of course, in the summertime the drips pumping is just a routine matter, for very little liquid accumulates in the drips pots. It is against the law for it to rain in California between the first of May and the first of October. Although there are some few violations they do not amount to much and cause no chilling of the lines. In the winter though, it is a different story. Cold rains chill the field traps, increasing the viscosity of the crude and making it more frothy. This causes considerable carry-over of crude into the gas lines. Also, there is considerable condensation of gasoline vapor especially the heavier fractions and these will fill up drips that are too small and will start surges in the lines. Being cold, this heavy gasoline acts as an ideal absorbent for lighter fractions surging through it with the gas, and some lines will carry gasoline that is almost "white." The gas from some of the wells in this system is more than 50 per cent gasoline vapor and is easily condensed by a cold soaking rain. It is when we get such rains that the truck operator is really busy. By watching his chart and his record of what he takes out of each drip, he can advise the field foreman in which locations the drips are too small and in which lines he thinks additional drips should be installed. The field engineer also studies this chart and plans changes and improvements by what it tells him.



A drips storage tank.



Evaporator converted for drips.

Proper disposition of the drips is just as important as is keeping them out of the lines. In the summertime we get nothing but crude oil from the lines and not a great deal of that except when a trap sticks. There is, of course, always a certain amount of crude mist in the gas but this stays in suspension and does not settle out in the lines. Very efficient mist extractors are provided ahead of the compressors to keep crude in this form from contaminating the absorption oil. In the winter though, considerable crude comes through even past the drips and into these separators. The drips truck in the winter time brings in a lot of off color gasoline. This is gasoline that showed up in the tests on the individual wells as gasoline vapor and it must be included in the plant production and prorated according to the tests.

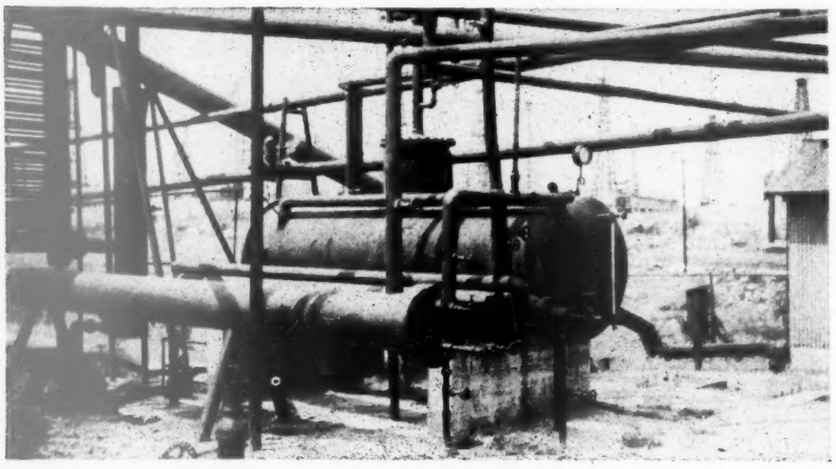
This gasoline is stored in large storage tanks and then pumped at a controlled rate through a heater and into a small evaporator separate from the main plant. This evaporator has an overhead dephlegmator equipped with an efficient mist extractor and the condensed overhead goes into the fat oil stream leaving the absorber. There is a definite reason for handling it in this manner. This gasoline contains some of the heaviest fractions. These fractions in warm weather come into the plant as vapor and in their course through the absorbers, dephlegmator and condensers absorb and hold the lighter fractions. If these heavier fractions are missing, especially from the condensers, we have a much higher content of the lighter fractions to recycle with the fixed gases off the condensers. We feed this heavier gasoline at a rate proportional to the amounts in which it comes in from the drips and as the weather clears up and the input into storage drops, we slow down on the rate so as to have some going through the plant until it quits coming in.

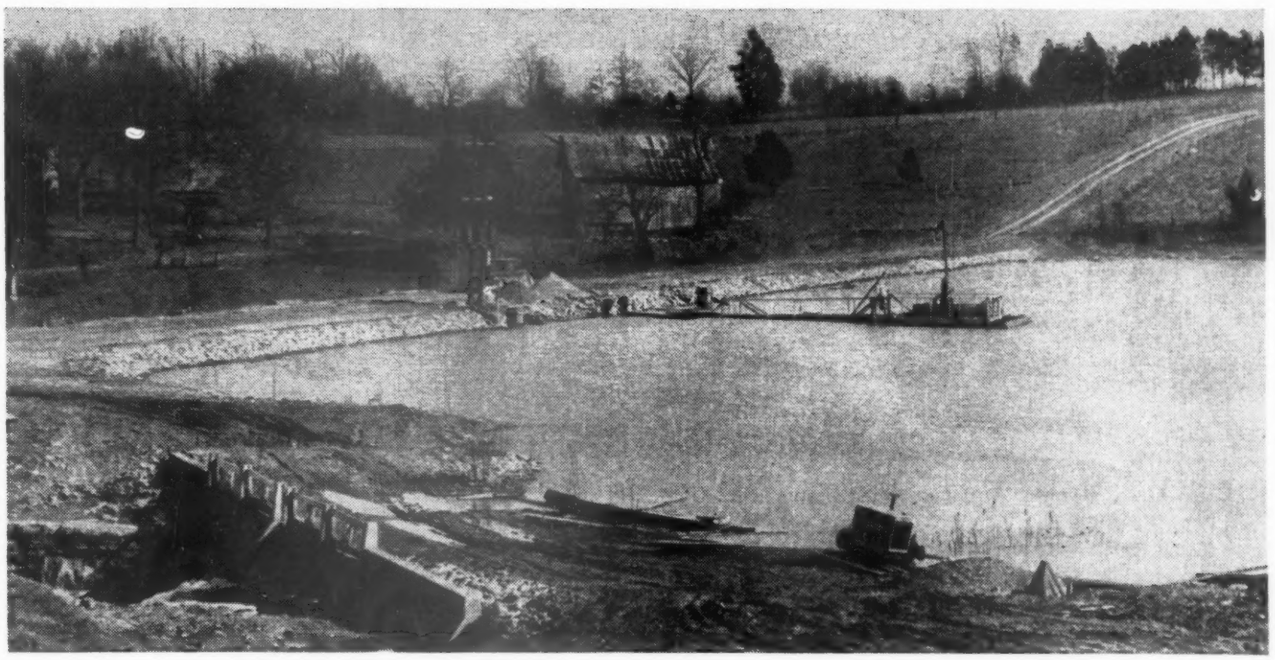
The residue from the bottom of the evaporator is disposed of with the crude oil. The mist extractors ahead of the compressors have float controls operating pumps that pump out any slugs of oil that come through when a trap sticks or a drip fills up and overflows into a main trunk.

A poorly laid out gathering system is a challenge to the field engineer but diligence, perseverance, and determination, aided and abetted by a proper background of education and experience, will work wonders and well-planned investments will pay good dividends.

★ ★ ★

Pre-heater and horizontal evaporator for drips.





Water pump float in lake, compressor station No. 11, Portland, Tennessee.

Construction of new compressor stations on Texas to West Virginia gas pipe line

By **HAROLD DAWE,** Gas Engineer, The Stearns-Roger Manufacturing Company

PART 2—Conclusion

● **Compressor stations.** Accompanying is a typical flow diagram of the compressor stations. The flow diagram indicates the main gas flow through the station, together with the flow of cooling water through the compressor generators and cooling coils and the arrangement for starting air. All stations have followed the same general design as shown in this flow diagram.

● **Piping design.** In general, piping design followed Section 3, Division 2, of the Code for pressure piping promulgated by the American Standards Association under the designation ASA-B-31. 1-1942; however, a more rigid standard was established in that no material lower than the 300-lb. ASA standard was employed in gas service. Also, no miter cuts were permitted in pipe in gas service.

In previous stations, large expansion loops were installed as in Fig. 12 to take up expansion in the discharge branches connecting to the main header. This loop had the disadvantage of many similar installations in that vibration seemed to be particularly concentrated in the loop. This loop flexed with each compressor cylinder discharge and acted the same as a Bourdon tube in a pressure gauge. As a partial solution these loops were supported and held down later by braces to each of the header pipe piers. Vibration was excessive at the cooling tower inlet and outlet lines to the gas cooling coils. Braces between pipes and concrete blocks were installed to minimize this vibration.

To prevent a recurrence of the vibration trouble, it was determined by the design engineers to use some method of reducing the compressor gas pulsations as near the origin as possible. Accordingly, a pulsation dampener was designed in place of the conventional outlet volume chamber. One such dampener was installed immediately below the outlet of the compressor cylinders. The arrangement is shown in Fig. 14. The upright expansion loops were eliminated in the branch discharge lines and 90-deg. reverse expansion bends laid down flat as in Fig. 13 were installed. The compressor gas discharge header was reversed with the suction gas header and placed nearest the compressors. Only light strap type pipe guides were provided except at the center of the main discharge header, where a stationary anchor was provided to control expansion. Actual operating conditions have proved that these devices have eliminated practically all vibration difficulties. There is very little noticeable vibration in the compressor branch lines, the main gas headers, or in the gas line to the cooling coils in the cooling towers.

● **Dust scrubbers.** The inlet gas to the station is piped through 24-in. pipe to a battery of dust scrubbers. Four of these scrubbers are installed in all stations at present. These scrubbers are 5 ft. in diam. and have a net shell length of 20 ft. Each vessel is designed according to the API-ASME code for pressure of 786 lb. at a temperature of 100°F.

Each scrubber is designed to have a capacity of 75,000,000 cu. ft. per 24 hr. of gas. There is a 12-in. bypass around these units to permit taking one unit off the line in an emergency.

In the previous stations the dust scrubbers were designed to have the outlet from the top head. The present scrubbers have the outlet on the side of the vessel near the top head seam. This change in design has resulted in piping to the vessel being more rigid. This has overcome the tendency of the longer and more flexible outlet lines from the scrubbers to vibrate.

The scrubber oil settling tanks and

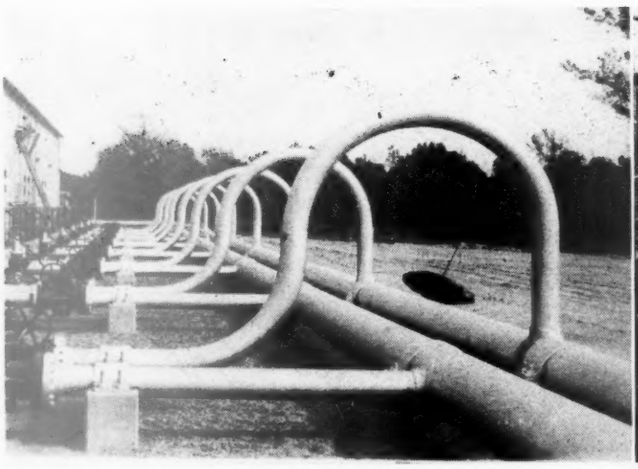


FIG. 12. Original expansion loop design in compressor discharge lines.

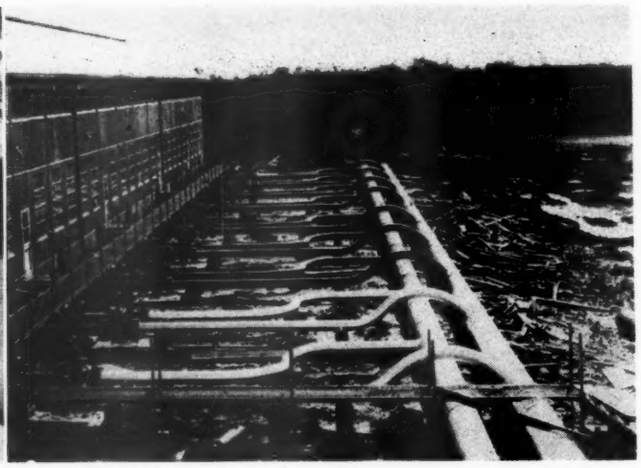


FIG. 3. Latest design for expansion in compressor discharge lines.

scrubber oil charging tank are mounted on a steel framework. The dirty oil blown from the base of the scrubbers enters directly into either of two 5-ft. by 5-ft. tanks, where the dirt is allowed to settle from the oil. The oil, after the dirt has settled, is drawn off through a swing suction line to the scrubber oil charging tank. A 3-in. line with shut-off valve is provided from the bottom of each tank. This is designed to drain the accumulated dirt and settlings into suitable containers for disposal, road surfacing, etc.

The vents, hatchways, etc., in these scrubber oil settling tanks are made completely waterproof. This was necessary to prevent moisture from entering the oil, carrying over to contaminate the dehydrated gas.

For filling the charging tank, a 14-gal.-per-min. herringbone gear type pump, with built-in safety valve, is provided. This pump is so manifolded that it takes suction from the lower half of either scrubber oil settling tank and discharges into the filling tank.

The gas leaving each scrubber passes through a vertical section of 12-in. pipe. In each 12-in. run an orifice plate has been connected to manometer tubes to permit evenly dividing the gas load to the scrubbers.

● **Compressors.** At Station 7 there are installed nine 1000-hp., in-line angle type gas-engine-driven compressors. These machines are placed end-to-end in a 30-ft. by 320-ft. steel-frame corrugated galvanized iron covered building, having a full ridge vent. This building has a bridge type traveling crane operating the full building length. A full basement is provided in the building; however, due to the use of piling, the whole structure is carried almost above ground level.

The compressor units are interconnected by means of a continuous walkway having steps down to the compressor room floor at alternate engines. Full basement ventilation has been provided. Stairs have been installed in both center and ends of the building to provide access to the basement from the inside or outside of the building.

There are two uninsulated silencers per engine and each silencer exhaust line has a metal jacket that serves to carry heat radiated from the exhaust pipe to the outside of the building. A vent stack on this jacket is provided with a damper to enable the amount of hot air vented to be controlled. This materially reduces the building heating load in cold weather.

Air cleaners have been provided and installed on an 18-in. air intake line to all compressors. There are no backfire relief valves provided. These proved to be a constant source of noise and maintenance at the original stations and have been eliminated. Air intake silencers have been installed to minimize the pulsation caused by the single scavenger cylinder per engine. These silencers are very effective in reducing the vibration caused by the pulsation of air.

At Station 11 are installed eight 1000-hp. V-angle type gas-engine driven compressors. These engines are placed in a single row side by side with crankshafts at right angles to the long axis of the buildings. These engines are installed with one air cleaner and one silencer per engine. Backfire relief valves are installed.

In Stations 9 and 13 there are installed, respectively, seven and six 1200-hp. in-line angle type gas-engine-driven compressors. This marks the initial use of these 1200-hp. engines in any service as they were only in the design stage when originally purchased. They are installed side by side with the crankshafts at right angles to the long axis of the building. These engines are provided with two air cleaners and one exhaust silencer per engine. There are no backfire relief valves provided.

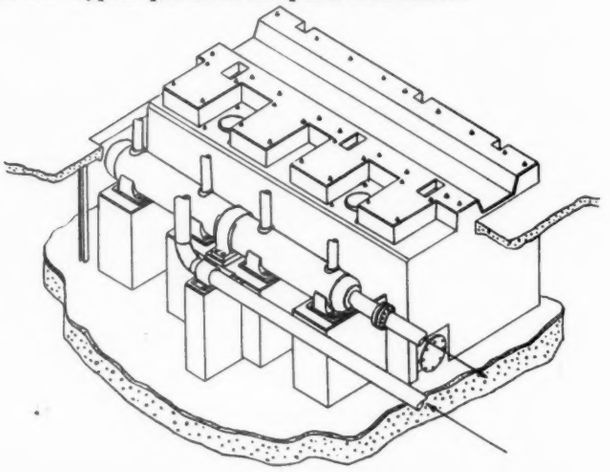
The buildings housing the engines in Stations 9 and 13 are 34 ft. by 192 ft. by 20 ft. and 34 ft. by 168 ft. by 20 ft, respectively. In these stations the compressor foundations are deep and a full basement is provided. Basement ventilation is also provided as in Station 7.

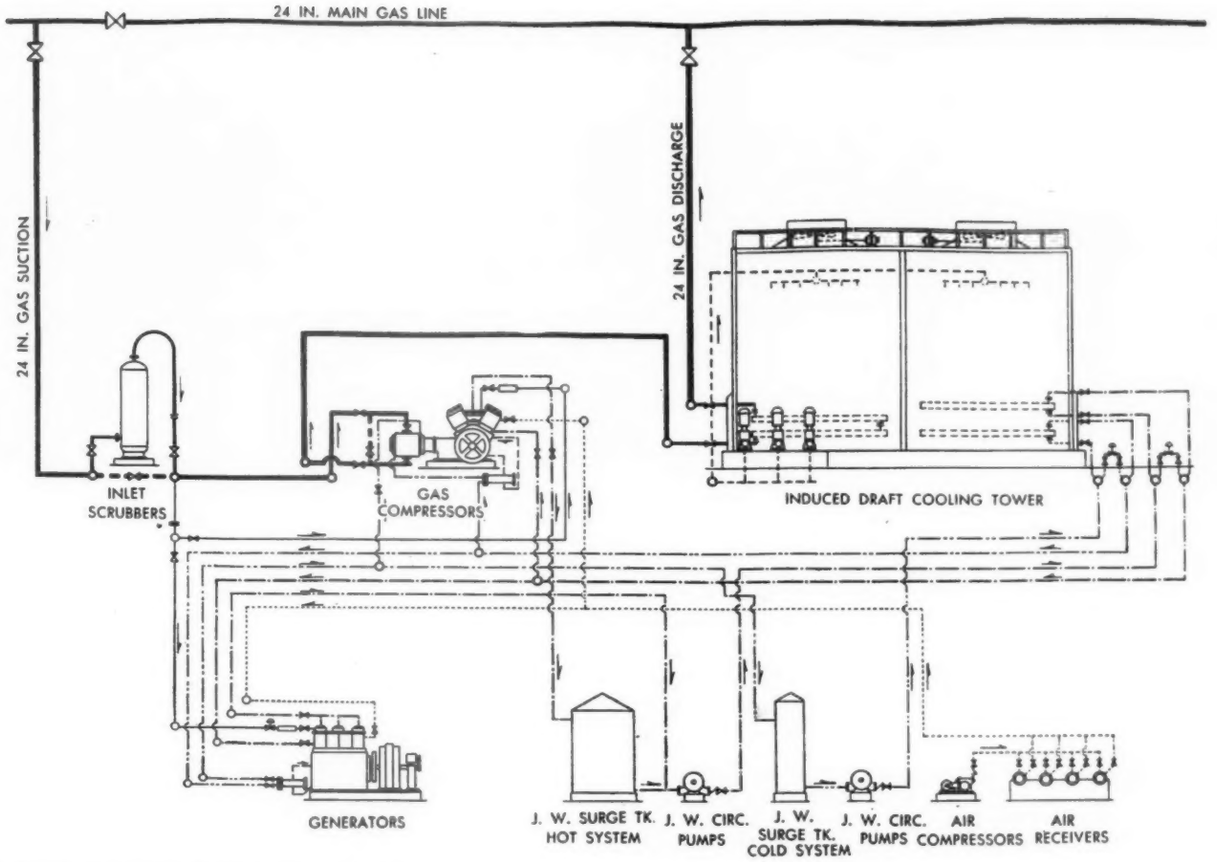
Stairways afford access to the basement at either end of all compressor buildings and a central stairway to the compressor floor midway in the building affords an additional exit from the basement.

Advantage is taken of the basement to house the oil reclaimer units, dirty and clean oil tanks, drainage sump pumps, and fuel gas air and water headers.

The gas will be compressed from ap-

FIG. 14. Typical pulsation dampener installation.





COMPRESSOR STATION FLOW DIAGRAM.

proximately 500-lb. to 750-lb. In this case the compressor ratio is less than in the original stations and the heating effect of compression is reduced. The compression ratios per station are shown in Table 1.

The compressor units in Station 7 are provided with three compressor cylinders 8¼ in. in diam. with a stroke of 15 in. The compressor units in Stations 9 and 13 have four compressor cylinders 7½ in. in diam. with a stroke of 17 in. The compressor units in Station 11 have four compressor cylinders 7½ in. in diam. with 14 in. stroke. All cylinders on all compressors are provided with built-in clearance pockets to provide the necessary clearance for the present design.

● **Compressor ignition.** Engine ignition is a direct-current-impulse type with individual induction coils for each spark plug.

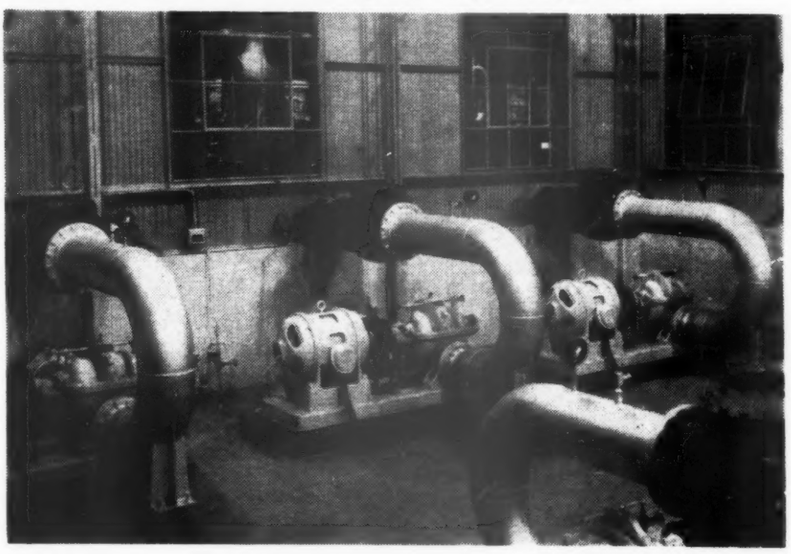
Instead of the conventional magneto source of power to the ignition coils there is provided an individual d-c. rectifier of the copper oxide type for each engine. These units are supplied from a 440-volt, 3-phase, 60-cycle source having their own built-in transformers and provide a virtually rippleless 10-14 volt, 2 to 4 amp. direct current that will supply the ignition demands of all engines. Each unit has its own volt and ampere meter built-in circuit breaker and rheostat for varying the voltage as required. These units are oil immersed. The dry type unit used in the original stations is felt to be less satisfactory than the oil immersed type. There are no batteries in the ignition circuit.

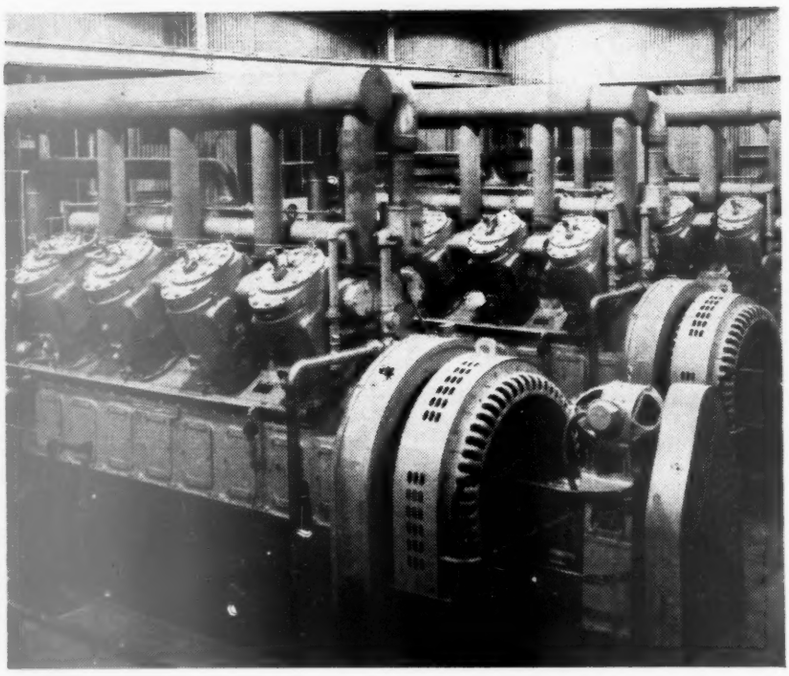
This system of ignition was developed for the first time for the original stations and has been thoroughly tested under actual pipe line operating conditions for more than two years. It has provided a clean and trouble-free source of direct current.

One distinct advantage of this system is that it provides a fool-proof interlock between the station electric generators, water circulating pumps, and engines. If the electric power fails for any reason the water circulating pumps on the jacket water system, being electric driven, necessarily shut down. As a compressor ignition system will also shut down upon power failure, the compressors are stopped at once, making it impossible for them to become overheated by running after failure of the jacket water circulation.

Another advantage is that each machine has its own individual rectifier unit and thus is independent of all the other machines. The entire station can-

Hot circuit pumps and cold circuit pumps (right foreground).





Generator installation, Station No. 13, Winchester, Kentucky.

not be shut down through failure of an element of the ignition supply, which is always a possibility where a central battery-charger system is used.

Finally, the system is actually cheaper to install and cheaper to maintain than either individual magnetos or a central battery-charger.

● **Oil system.** Two oil reclaimer units are installed in the basement at each station. These units are so arranged that the oil from any engine may be treated and returned to that engine.

An oil drain header is installed in the basement and connected to the compressor rod packing gland housings. This header is also connected through valves to the crankcase of each engine. The compressor rod oil drips enter this line and flow to a dirty oil tank; also, when an engine is taken off the line for maintenance, the oil may be drained to the dirty oil tank and deliver the reclaimed oil to the clean oil tank. A manually operated dispenser pump is placed on the compressor floor, and takes suction from the clean oil tank.

Two additional lube oil dispenser units with counters are installed in each compressor building. These pumps are directly connected to the fresh oil supply, which is stored in a horizontal 10-ft. by 20-ft. main lube oil storage tank installed near the building.

There is a drain pan in the compressor floor directly connecting into the dirty oil tank, and another connecting into the clean or reclaimed oil tank. In case polluted oil must be disposed of, it may be poured into the dirty oil tank, and clean oil may be returned to the reclaimed or clean oil tank through these drain pans. This lubrication system provides for flexibility in handling lube oil and with a minimum of waste.

● **Gas cooling.** The 24-in. gas discharge header extends to the cooling tower, where the gas enters atmospheric cooling sections. These sections have been selected to obtain a low pressure drop. They are provided with 8 in. inlet and outlet nozzles and each bank is individually valved. The sections are connected in parallel banks of two sections each, in series, with an upward flow. In all stations, 800-lb. single-pass sections are used.

The main gas inlet header and each lead to and from the coils is provided with an industrial thermometer. The gas flows from the cooling sections into a 24-in. outlet header and thence directly to the main pipe line.

● **Cooling towers.** The cooling towers are the induced-draft back-to-back type and are identical.

Spray water requirements for Station 7 are 8000 gal. per min., for Stations 9, 11, and 13, 8960 gal. per min. Station 13 cooling tower has been sized so that an additional compressor engine may be added at some future date.

The design temperatures of basin water for towers is 92°F. The water is cooled to 80°F. in these towers with 75°F. atmospheric wet bulb.

Three pumps have been installed per tower for the circulation of spray water. They are vertical single-stage turbine-type pumps, electric motor driven. In Station 7 each of these pumps handles 4000 gal. per min. and is driven by a 60-hp. electric motor.

In Stations 9, 11, and 13 each of these pumps handles 4500 gal. per min. and is driven by a 60-hp. electric motor.

The pumps are mounted at one end of the tower, over a sump that communicates through double screens with the basin proper. Each pump discharges through an 18-in. check and gate valve to a 24-in. header line. Water is taken over the tower through three 16-in. risers. There is a pressure blow-down connection on the high pressure recirculating water pumps so that the concentration of the salts in the basin may be kept down.

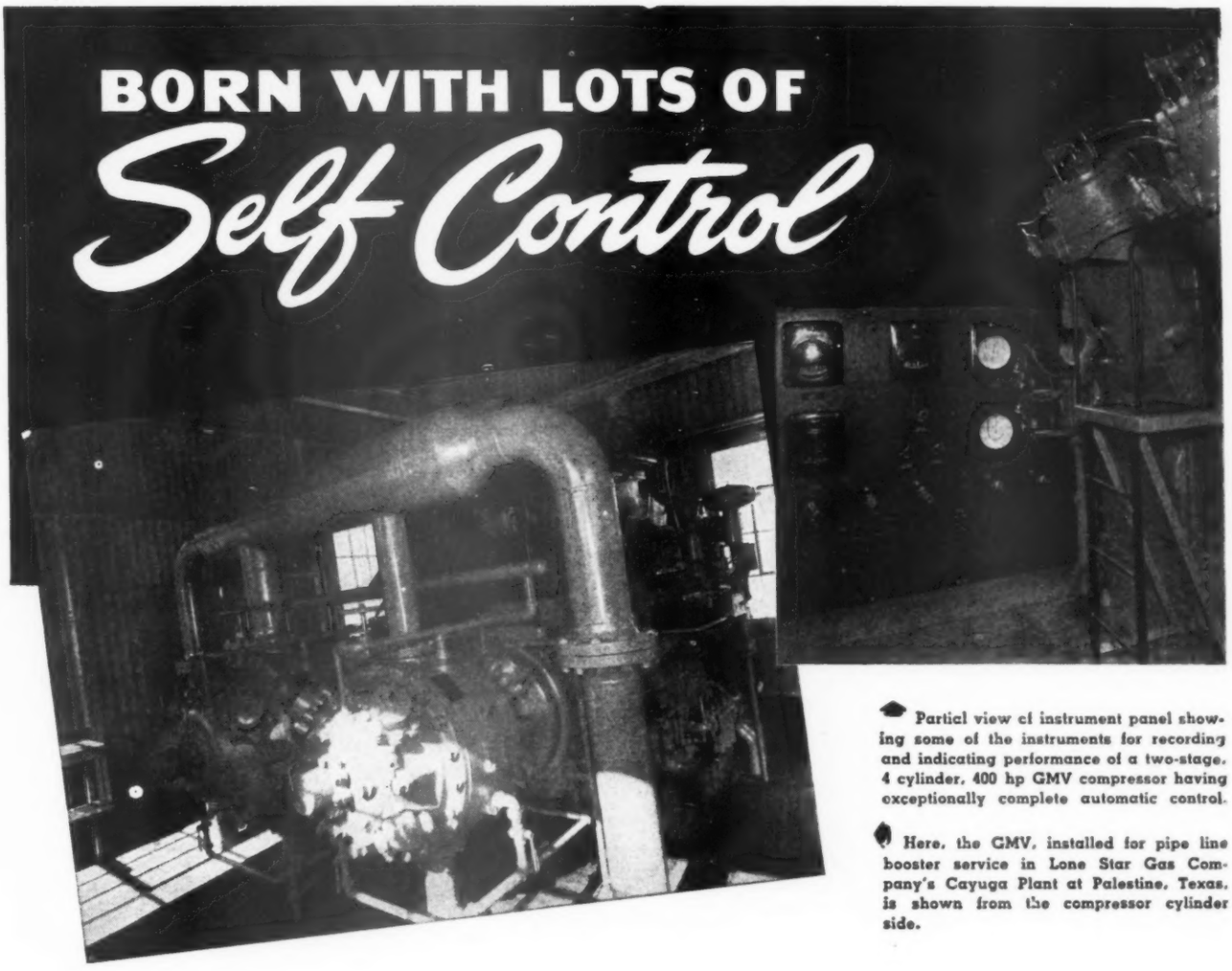
Cooling water is made up to the tower through a 4-in. line. There are no automatic float make-up valves used, but there is a 4-in. displacement type meter on the inlet water line. This provides an accurate method of maintaining control over the makeup and assures a constant wastage.

● **Cooling water system.** In selecting the proper cooling system, the principal objective was to attain a cooling system that would permit of not more than 10° F. temperature rise through the power cylinder jackets, and with a minimum power consumption. All manufacturers contacted agreed that a 10°F. rise through the jackets of the engines was desirable for best engine performance.

The system chosen and installed calls for two separate cooling water circuits. The "hot" circuit circulates water

Interior compressor building, Station No. 7, Greenville, Mississippi.

BORN WITH LOTS OF *Self Control*



Partial view of instrument panel showing some of the instruments for recording and indicating performance of a two-stage, 4 cylinder, 400 hp GMV compressor having exceptionally complete automatic control.

Here, the GMV, installed for pipe line booster service in Lone Star Gas Company's Cayuga Plant at Palestine, Texas, is shown from the compressor cylinder side.

HERE, in Lone Star Gas Company's pipe line booster station at Palestine, Texas, is a good example of an almost entirely self-controlled compressor — a Cooper-Bessemer GMV. In fact, control is so completely automatic that the operator checks this unit only once each 24 hours. Except for changing spark plugs, this unit has been on the line continuously since it went into service midyear in 1945 — a completely satisfactory installation.

To maintain uniform suction pressure, this GMV has a diaphragm regulated governor, automatically controlling engine speed between 225 and 300 rpm, combined with a 5-step pneumatically operated compressor unloading system. Inversely, if discharge pressure becomes too high, overloading the engine, controls prevent the last step of loading. And, in addition, this modern GMV has automatic cutout controls to protect it against low oil pressure, high oil and water temperatures, overspeed, broken intercooler, discharge or suction lines, and broken valves.

Of course such extensive automatic control may not be necessary for the average pipe line compressor installation. Nevertheless, this and many similar Cooper-Bessemer installations in pipe line service, in refineries and in the processing and synthesis industries do attest the welcome flexibility, the quick, positive response, and the exceptional reliability afforded by GMV's whether control is completely manual or semi or entirely automatic.

The
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through compressor engine cylinder jackets and electric generator engine cylinder jackets in parallel, and thence through cooling sections mounted in the cooling tower. The entering water is at 140°F. and the temperature rise is 10°F.

The water is circulated at Station 7 using two 3600-gal.-per-min. horizontal double-suction single-stage centrifugal pumps driven by 60-hp. electric motors.

At Stations 9 and 13 the water is circulated using two 3600-gal.-per-min. horizontal double-suction single-stage centrifugal pumps driven by 75-hp. electric motors.

At Station 11 the water is circulated using two 3600-gal.-per-min. horizontal double-suction single-stage centrifugal pumps driven by 100-hp. electric motors.

The difference in the horsepower required for this pumping duty is due mainly to the difference in pressure drops through the jackets of the compressor engines. Station 13 cooling system has been sized to handle the installation of an additional compressor in the future. Two pumping units are required for normal operation and a third unit is provided for a spare. A 10-ft. by 20-ft. vertical surge tank is provided on the suction of the pumps.

As two of these units run continuously, no emergency control has been provided on these pumps. If one pump should shut down, the second pump will maintain sufficient circulation to prevent damage until the spare pump can be started, or the compressors and generators shut down. A pressure switch is installed on the pump discharge that sounds a warning signal on low pressure or pressure failure.

The pumps force the jacket water through a 24-in. header to the cooling tower, where it flows upward through parallel banks of atmospheric cooling sections in the cooling tower. These coils have 8-in. inlet and outlet nozzles, and have a 6-lb. pressure drop.

Industrial thermometer wells are installed in each inlet and outlet line.

To control the outlet water temperature from the engines, a temperature-controlled bypass valve is connected across the inlet and outlet water headers.

In the secondary or "cold" circuit, the water passes through the oil coolers and the compressor cylinders in series. The water from the compressor cylinders flows to a 4-ft. diam. by 20-ft. high surge and vent tank connected in the circuit and merges with the water from the generator oil coolers at the suction of the recirculating pumps. The pumps discharge the water through a 14-in. header to the cooling tower and through parallel cooling sections.

Water circulation in the "cold" circuit is maintained at Station 7 by use of one 1335-gal.-per-min. horizontal double-action single-stage centrifugal pump driven by a 25-hp. electric motor.

At Stations 9 and 13 the pump for this service is rated at 980 gal. per min. and is driven by a 20-hp. electric motor.

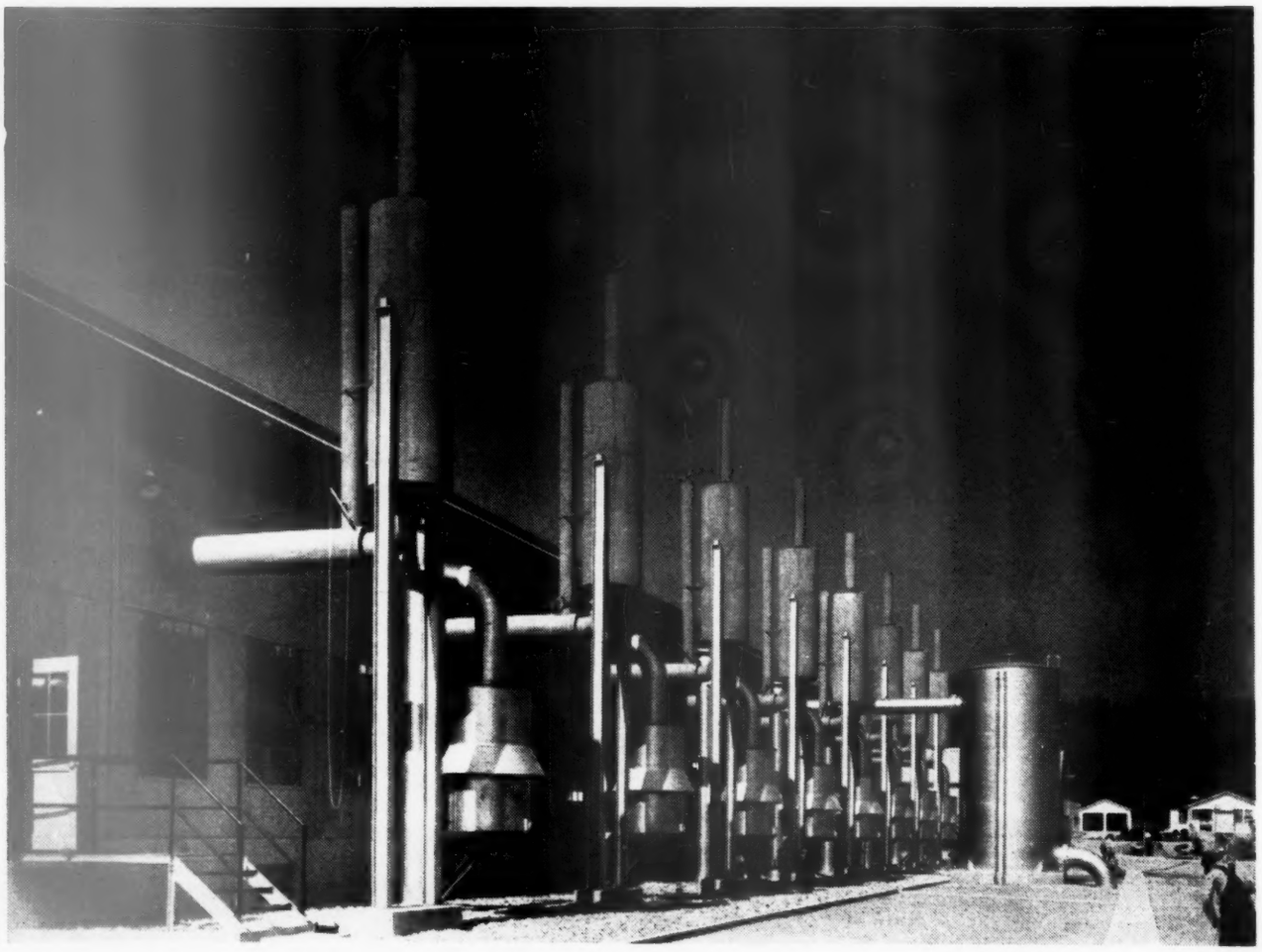
At Station 11 the pump is rated at 1818 gal. per min. and is driven by a 30-hp. electric motor.

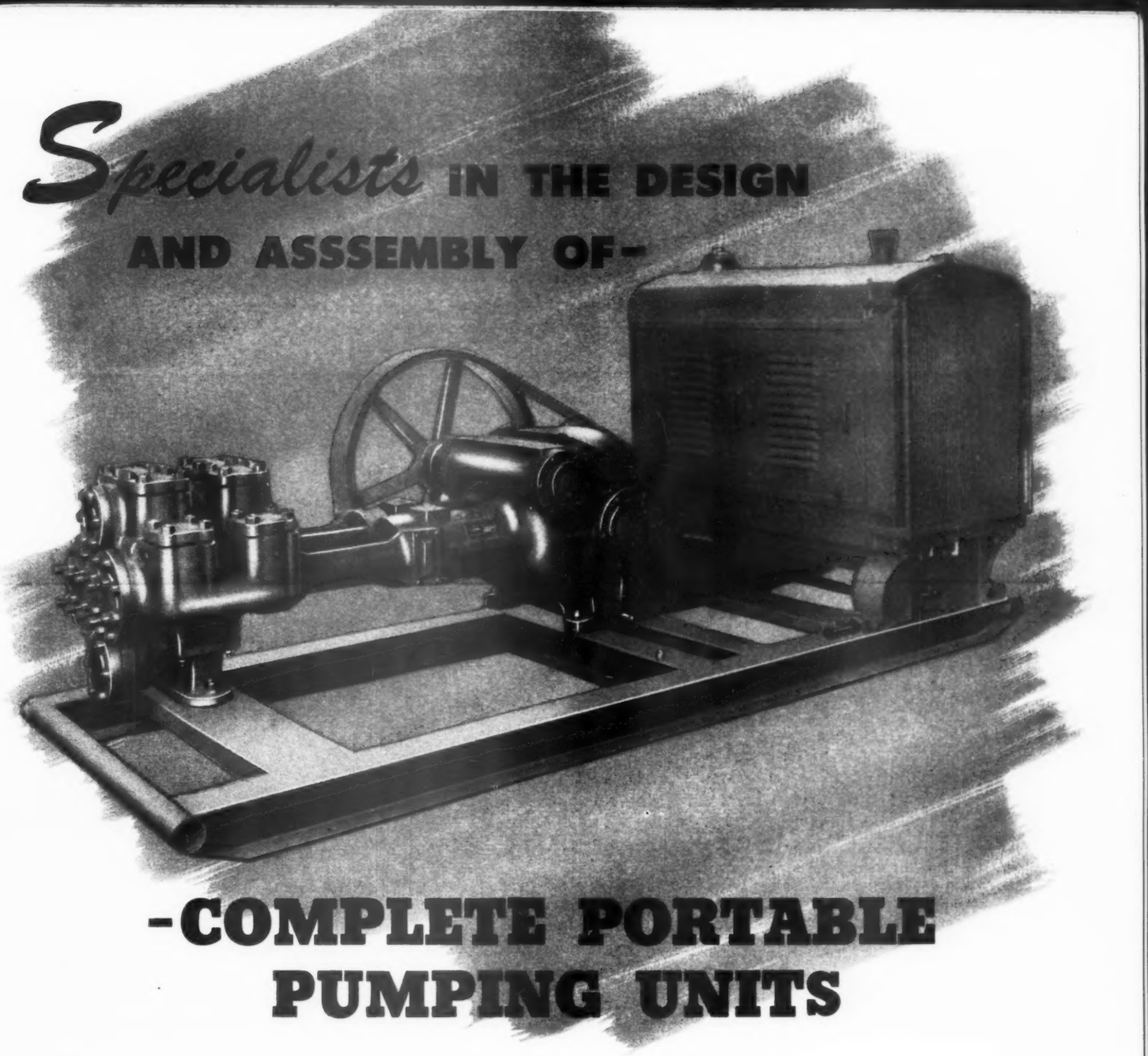
In this system, one pump runs continuously and one pump acts as a spare. No automatic starting system for the spare pump has been installed, for a failure of cooling in this system will do no damage before necessary operations may be changed. To control the temperature in the cold circuit, a temperature-controlled bypass valve is connected across the inlet and outlet headers to the cooling sections.

● **Electric power system.** Electric power for each compressor station is generated by three gas-engine-driven generators. In Station 7, the 4-cycle gas engine drives are rated 400 hp. at 450 r.p.m., and in Stations 9, 11, and 13 the units are rated 370 hp. at 400 r.p.m.

The generators of all units are of the

Compressor building showing silencers and air cleaners at Portland, Tennessee, station.





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standard open frame engine type, rated 312 kva., 250 kw., 480 volt, 3 phase, 60 cycles with a 40°C. rise. The generators are equipped with 7½ kw., 125-volt, 1750 r.p.m., V-belt connected exciters.

Each engine has the exhaust muffled by a silencer. Intake air is cleaned by an air cleaner fitted with a backfire relief valve.

The generators feed electric energy directly to a buss system contained in a unitized totally enclosed control center. From the center electric power is distributed to all parts of the station. All electric motors are push-button controlled from the control center.

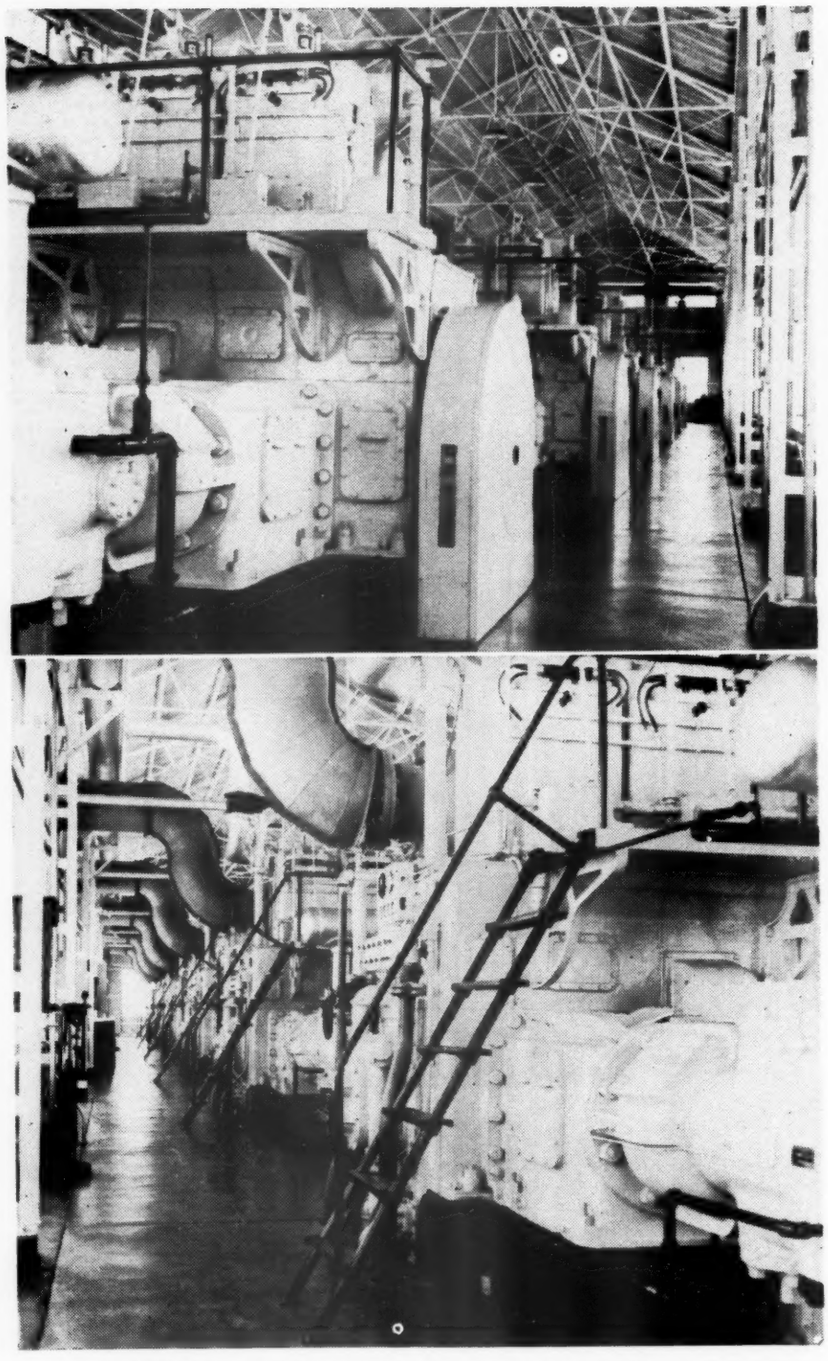
A separate control center is provided and housed in half of the water treating building for controlling the cooling tower fans and circulating water pumps.

The generator units are housed with the cooling system pumps and starting air compressors in a steel frame, galvanized iron covered building, 40 ft. wide by 78 ft. in length. A full bridge type crane-way is provided for convenience in overhauling generators and pumps. The pumps are placed in a 3 ft. deep pit at one end of the building and are reached by stairs. At Station 7 there is no pump pit, all equipment is placed on one level.

In all stations, the starting air units consist of one electric-driven air compressor and one combination electric motor and gasoline engine drive air compressor. All air compressors have a capacity of 40 cu. ft. air per min. so that each station has a total capacity of 80 cu. ft. per min. These compressors discharge into four 30 in. by 15 ft. air receivers designed to operate at 250 lb. pressure. The air tanks have pressure gauges and relief valves.

A small oil reclaimer unit is installed in each generator building, and operates on the three engines. A dirty oil tank is provided to allow crankcase oil from any engine to be drained. The reclaimer unit takes oil from this tank, cleans it, and discharges it into a clean or reclaimed oil tank provided with a dispenser pump. Oil makeup may be from this tank or from another dispenser pump connected to the 10 ft. by 20-ft. main lube oil storage tank.

● **Water supply and storage.** At Stations 7 and 9, from their location and based on previous experience, it was indicated that adequate water of good quality could be procured by the drilling of water wells. Two water wells of approximately 200-gal.-per-min. capacity have been drilled and electric-motor-driven well pumps installed. These water well pumps have a discharge pressure of about 40 lb. Previous experience had also indicated that at the locations chosen for Stations 11 and 13, it was unlikely that sufficient water would be found by drilling water wells. Accordingly, the desired water was sought in nearby streams or lakes. Fortunately at Portland, Tennessee, there was a sportsman's lake confining a large body of water fed by underground springs. The City of Portland was able to arrange for the use of this water supply and a 6-in. supply line was installed from Station 11 to this lake. This line was about 4½ miles long.



At Middleton and Winchester stations, 1200-hp. in-line angle-type gas-engine-driven compressors were installed, their initial use in any service.

Two electric-motor-driven vertical pumps were installed in the lake on a float made from 24-in. line pipe. The float was anchored by cable and connected to the shore line by a long walkway. Flexible hose was used to connect the pump on the float to the pipe line on the shore.

At Station 13 it was necessary to go to the Red River, about 4 miles from the station, for water. This river, according to all sources of information, flowed considerable water through the driest years. At the site chosen for the pumping station on the banks of the river there was an old railroad bridge abutment. Two 48 in. pipe caissons were sunk out from this abutment. The lower part of these caissons was made of water well screen and was set at bed rock about 6 ft. below the low water level of the stream. Graded gravel rock and sand was placed about the screen and out into the stream bed itself. The whole backfill area was riprapped to prevent washing. The pumping station house was constructed on top of the caissons and houses an electric-motor-driven pump and a combination

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electric motor gasoline-engine-driven. pump. Provisions were made to electrically heat the building. Electric power was supplied by a local utility. From this pumping station a 6-in. pipe line was run to the station, a distance of about 4 miles.

It was decided that it was desirable to soften all the water supplied to the stations and a zeolite softening installation was made at each station. All water supplied was softened and stored in steel tanks. A 2000-bbl. water storage tank was provided at each of Stations 7 and 9 and a 7000-bbl. tank at Stations 11 and 13.

Water supplied to the cooling towers is chlorinated after softening. Chlorination equipment was used in these stations in place of the previous organic chemical treatment, which proved to be harmful when it was wasted into small local streams.

No treatment for engine cooling water is planned outside of water softening, but provision has been made for injecting inhibitor or other chemical when and if required.

● **Fuel gas system.** The fuel gas to each station enters a pilot-operated primary fuel gas regulator where the pressure is reduced from 400 to 100 lb. The 100-lb. gas from this regulator enters a secondary pilot-operated fuel gas regulator where the pressure is reduced to fuel requirements. These regulators are duplicated by regulators in parallel; either will handle the full fuel requirements for the compressor station. Each of these regulators will close upon its pilot failure, the other regulator then taking the full load of the plant.

Gas entering for fuel is heated by the hot system jacket water, the heat exchange being through a finned tube exchanger. This system has been quite effective in preventing freezeup of the regulators.

The gas from the primary fuel gas regulator enters a volume chamber where the flow of gas is smoothed out. The regulator control pressure line taps into this volume chamber, the reserve volume of gas preventing regulator "hunting." The secondary regulator is on the downstream side of the primary volume chamber, and regulates gas flow into a secondary volume chamber. This chamber is protected by a safety valve. Gas flows from the secondary chamber into an orifice meter run. The fuel gas requirement for the station is metered through this run by means of a standard orifice meter. A recording thermometer is also installed in this run. The gas is then supplied through a 10-in. fuel gas header to the compressor building, and through a 4-in. line to the generator building.

The generator fuel gas regulator is a sensitive type regulator that drops the pressure from 45-60 lb. to 1 lb. into a small volume tank, which is protected from overpressure through a diaphragm control valve acting as a relief valve. The gas from the regulator volume chamber then enters the 6-in. generator fuel header. Each generator is equipped with a sensitive fuel gas regulator, reducing pressure from 1 lb. to 3 in. of water. A volume tank is provided between the generator sensitive regulator and mixing valve.

The compressors do not have individual regulators, but a large main fuel header is installed and each compressor is provided with a large fuel volume chamber to smooth out surges and provide additional volume.

The primary and intermediate regulators, volume chambers, and 6-in. meter runs, are housed in a separate steel frame corrugated galvanized iron building. The generator fuel regulators are housed in the auxiliary building.

The gas fuel to the office building, camp pipe-line warehouse, machine shop and change room building is measured through a displacement meter, and the pressure is reduced at each building by regulators handling the required amount of fuel gas. These regulating valves have built-in relief valves and automatic shut-off features.

● **Speed control.** As Station 11 is subject to some fluctuating demand, automatic speed control has been installed. These automatic controls maintain the station pressure as required. The control center of this system is a 2-pen pressure recorder-controller. One pen records station suction pressure; the second, or controller pen, is actuated from the discharge gas header pressure and controls air supply to a diaphragm motor with positioner for resetting the engine governor spring. A second diaphragm lever motor with positioner controls the scavenging air bypass and is in turn controlled by the gas manifold pressure. In action the automatic control acts to change the governor speed of the engine, and the amount of scavenged air is changed in proportion.

In all stations a 2-pen pressure recorder is installed in the compressor room and connected to record station gas discharge and suction pressure. These instruments may be changed later, if desired, to pressure controllers for automatic speed control service by inserting the pressure control elements in the instrument cases. A second instrument of the same type, except no controller, is installed in the office. This instrument records actual pipe-line pressures above and below each station. These are regularly dead-weight tested for accuracy.

● **Building heating.** Provision is made at all stations for heating the warehouse, shop and change room building, and pipe-line warehouse by means of individual gas-fired heater units. The offices are heated by individual room type heaters. The compressor building and auxiliary building at Stations 9, 11, and 13 are heated by means of 15-lb. steam. The steam is generated in a gas-fired boiler situated in the auxiliary building. Steam is piped to the compressor building through an underground conduit and thence to individual heating units.

All boilers are served by condensate return units. These units have their own makeup control, return tank for controlling makeup water, and charging pump for boiler feedwater. These units are mounted in the auxiliary building adjacent to the boiler and are situated in the pump pit.

The boilers are equipped with 20-in. by 25-ft. self-supporting steel stacks.

At each station a 20-gal. automatic hot water heater is installed in the office and a similar heater of 30-gal. capacity is installed in the change room. These units will provide hot water for lavatories and showers.

● **Maintenance facilities.** The maintenance building, which contains the shop warehouse, and change room building, is 30 ft. wide and 60 ft. long. The central section of this building, 30 ft. by 30 ft., is given over to warehouse space; bins are built along the walls and a small closed space is provided for housing electrical materials. One end of this building, 12 ft. by 30 ft., is given over to a change room for employe use. This change room is fully partitioned off and is provided with adequate locker space, wash basins, a shower stall, sanitary facilities, and laundry equipment.

The remaining space in the building, 18 ft. by 30 ft., is used for a maintenance shop. This section is provided with a monorail and hoist. This shop is equipped with lathe, drill press, arbor press, grinder, welding equipment, and necessary tools to handle all but major repair work.

● **Office and camp.** A wood-frame asbestos-shingle covered 3-room office is provided at each station. One room is provided for the station superintendent, one for district pipe-line superintendent, and one for clerical use. A leased line telephone connecting all stations is housed in a small booth, with the pressure-recording instrument. All offices are provided with attic-fan ventilation, complete sanitary facilities, and are completely insulated.

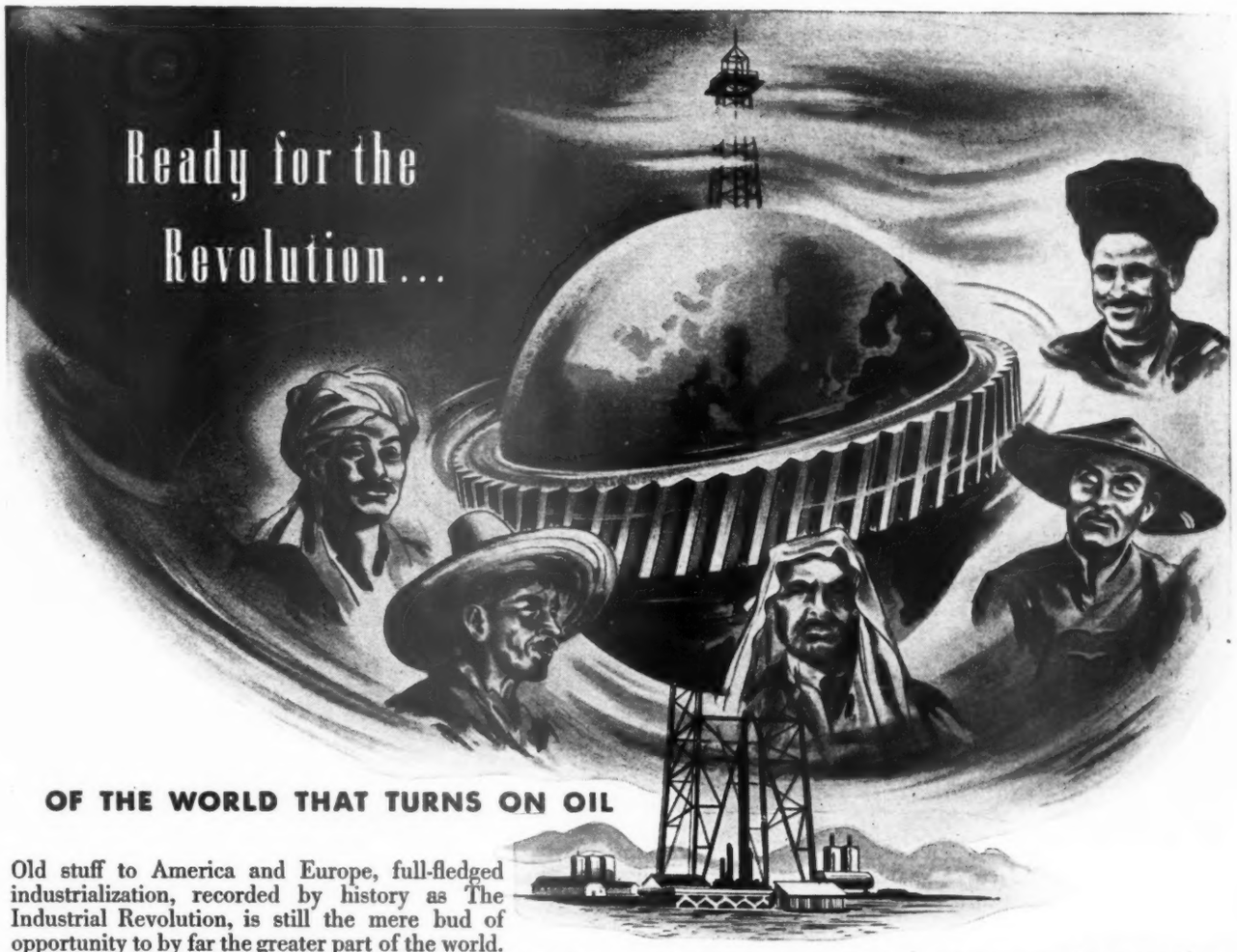
Camps have been built adjacent to the stations. At Station 7, near Greenville, Mississippi, there are only four houses; at Station 9, which is not near any large town, 15 houses have been built. These are arranged in the form of a large "U" and are separated from the station by a large grove of hardwood trees.

Station 11, also not close to adequate housing, was built with ten houses in the camp. These houses are arranged along the edge of a triangular plot of ground. The camp at Station 13, is built with 11 houses arranged in a long line along the contour of a hill.

All houses have been varied to some extent from the basic design in order to make them more attractive. Different porch arrangements, variations in the color scheme, and in color of roofing serve to increase the employe interest in these homes.

Complete sanitary facilities are provided for each camp, and all houses are provided with softened and chlorinated water from the main supply system. All are protected from fire hazard through a separate water system, fire hose, and hydrants. ★★★

(This is the second and concluding installation of Mr. Dawe's article on compressor stations.)



OF THE WORLD THAT TURNS ON OIL

Old stuff to America and Europe, full-fledged industrialization, recorded by history as The Industrial Revolution, is still the mere bud of opportunity to by far the greater part of the world. The blossoming of Asia, The Near East and South America promises fruit that Dresser Industries has long cultivated.

For the industrial world turns on oil. Oil lubricates the wheels. Oil, with gas, its sister under the earth's skin, fires the cylinders. And many a Dresser member company is well established in this fertile world market. The overwhelming majority of hot oil pumps in the refineries of Iraq and Iran, for example, were made by Pacific Pumps. Gas for the reborn French and Russian industries will be pumped by Clark compressors. Roots-Connersville blowers are used in large numbers by fourteen Latin American countries in as varied industries as rice irrigation and oil refining, tunnel ventilation and gas manufacturing. Ideco equipment is found in Turkey, Alaska, Russia, Arabia, Indonesia, North Africa, South America—and, in practically every active oil field in the world, may be found, also, Security rock bits and reamers.

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OIL AND GAS EQUIPMENT A SPECIALTY

General view of the Signal Hill and Long Beach field at the end of 1929. By this time more than 300 deep wells had been drilled, some of which penetrated the producing formation to a depth of more than 7500 ft.

The first 25 years at Signal Hill

By **RICHARD SNEDDON**
Pacific Coast Editor

EXCLUSIVE

SIGNAL HILL had no individual producer that could remotely stack up with the famous Lakeview gusher. It didn't turn out to be the most productive area in the world. It will probably come a long way short of being the longest lived field, even in California. But by and large, it is one of the most interesting developments in the State. From the standpoint of technological progress, the discovery either occurred appropriately at a normal transition period in the evolutionary trend, or actually promoted a trend of its own. In any case, there is no question that many of our modern drilling and production techniques were fired in the heat of this exciting development, to be later shaped and molded into their present form. By the same token, many of the men who now direct the California petroleum industry in its diverse phases, first exhibited here the understanding and initiative that are the fundamentals of leadership.

The discovery of oil on the Hill by Shell Oil Company on June 25, 1921, was a significant event in petrolic history, for out of the extravagant and unbridled effort that followed the completion of Alamitos No. 1 there came many lessons that have since been of incalculable value to the industry. The productive area was comparatively small — some 1400 acres have been proved to date — and ownership was divided among hundreds, perhaps thousands of persons, most of whom merely owned or had an interest in residential lots. Thus, when Hap Yowell and his crew tapped the pay sand, they really started something. The rush for property was a virtual avalanche, and the boom that followed was terrific.

Alamitos No. 1, on the lease of the Alamitos Land Company, was completed at 3114 ft. for an initial flow of 500 bbl. of 21-gravity crude a day, and, thereafter, of course, activity was concentrated in this immediate area, until late in the year when Shell brought in another one, Horsch No. 1, at 2730 ft., for 350 bbl. This well was half a mile northwest of the discovery, and demonstrated that the pool was larger than had been supposed. Still later, in January, 1922, the General Petroleum Corporation's Black and Drake No. 1 blew in out of control when drilled for a cement test at 2298 ft. A tremendous flow of gas from this well in the first stages wrecked the derrick, and then going to oil flowed at an estimated rate of 10,000 bbl. a day. This one wasn't far from the discovery well, so it didn't extend the field, but it definitely revised estimates of the richness of the pool.

In August of the same year, the Cal-Mex Kirkpatrick No. 1 was successfully

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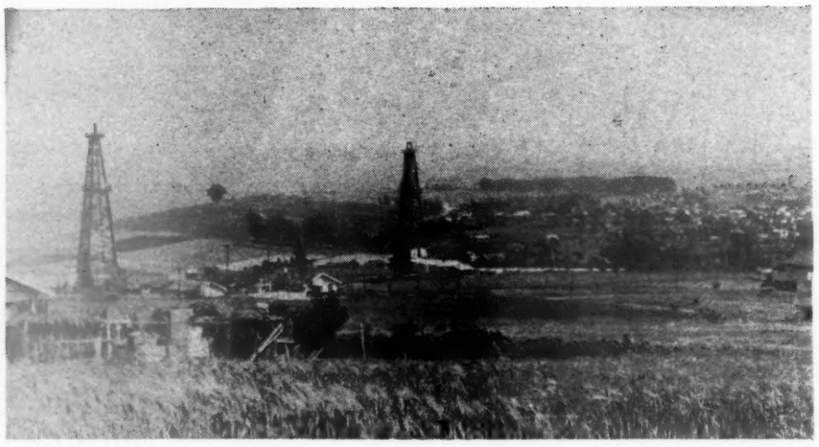


Signal Hill, May 30, 1921. Left, Shell's Alamitos No. 1; right, Sandberg and Co.'s No. 1. By the end of 1922 there were 138 operators, 395 active rigs, 361 wells completed and drilling, 148 wells producing, 1,600,000 ft. of hole drilled, average daily production of 100,000 bbl., cumulative production of 18,100,000 bbl.

brought in three-quarters of a mile from the top of the Hill, and demonstrated that the reservoir extended for at least another half mile beyond the Horsch property, that is, in a northwesterly direction. Then in March, 1923, the Shell Andrews No. 3, while drilling at 5050 ft., came in out of control, and for a time flowed at the rate of 30,000 bbl. a day. All these events and circumstances greatly stimulated development, which was already going ahead at an unprecedented pace, and as a result, despite catapulting property values, wells were drilled with a total disregard of the economics of production. Unitized operation was then practically unknown, and a multitude of small holders scrambled to get their share while the getting was good.

The largest lease in the field was owned by the A. T. Jergins organizations, and by April, 1922, a number of the major oil companies, other than the discoverer, notably General Petroleum Corporation, Union Oil Company, and Standard of California, were operating small parcels, but were being driven to distraction by the necessity of offsetting the townlot holders. The orderly conception of a well to every five acres was knocked into the proverbial cocked hat. As many as 25 were located on five acres in some sections, and every piece of property that was big enough to permit construction of a derrick floor was the scene of another foray. Many operators, now well known to the California petroleum industry, either had their start on the Hill, or there garnered the capital that strengthened and sustained them through the competition of subsequent years. Among them, to name a few, were William McDuffie, William Reinhardt, R. R. Bush, Dabney and Johnston, Jack Doyle, George F. Getty, Leonard Jones, W. M. Keck, W. R. Ramsey. Many have passed on, but none before he had made worthwhile contribution to the petroleum industry.

Southeast corner of the field, looking northeast, at the end of 1929. Production during this year dropped off about two million barrels, but 60 million a year is still a mighty profitable yield. The following year it was almost sliced in half, and from then to now has declined.

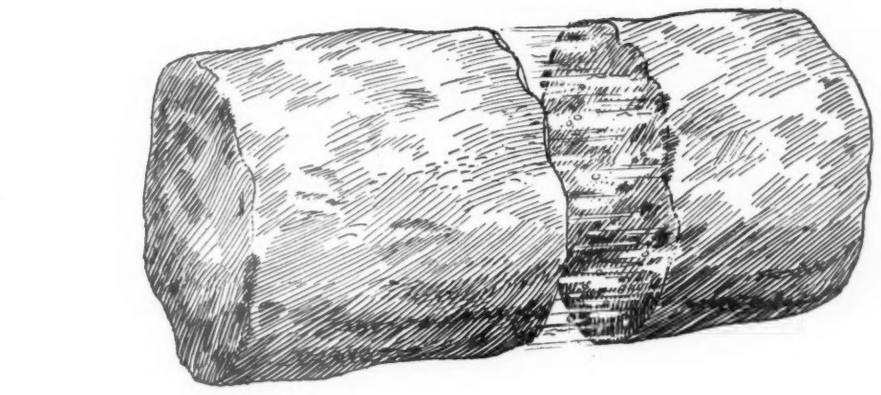
The field was developed at a rate never before approached in California, according to the records of the Department of Petroleum and Gas. In the early stages it even exceeded Huntington Beach, which in its first year filed 20 notices of intention to drill, as compared with 82 for the first active year on Signal Hill. By far the greatest number was filed by Shell Oil Company. The daily production as of April 30, 1922, was 14,000 bbl. —of which Shell produced 6000—and 15,000,000 cu. ft. of gas. Gravity of the oil varied from 21 to 24.5 deg. depending on the zone. Incidentally, gravities were reported in Baumé degrees at that time, so we may assume that the API scale had not yet been developed.

During the early development of this field the core barrel became a growingly popular device, and helped in such a material way to define underground conditions with some degree of accuracy that its acceptance thereafter as an effective exploration instrument was fully assured. Indeed, conditions in the field made it an excellent testing ground for the exercise of ingenuity and the application of new ideas and devices. It seemed to present every known production engineering problem in peculiarly concentrated form, and at the same time to pose a surfeit of entirely new ones. The maze of gathering lines and connections, through which the output of the wells was pumped into producers' or purchasers' storage, was something to behold. Small operators, in some instances not too well financed, erected all sorts of Rube Goldberg contraptions at the wellhead, while on the next lot the larger operator might display the very latest in equipment, and the ultimate in experienced help.

In general, Signal Hill is a prominence in a long uplift that stretches from the vicinity of Newport Beach to Howard Summit, near Inglewood, and it has been well exploited in the intervening 25 years. The structure appears to be an anticlinal fold with a northwest-southeast trend to the axis, and the location of the axis closely approximating the crest of the Hill. From its apex, the structure drops on both north and south flanks, in increments varying from 10 to 35 deg., the sharper inclination being on the south.

According to a comparatively recent report by Harry Stolz, the most important productive formations are in the Lower Pliocene (Repetto), and are divided into two zones—the Alamitos and the Brown. The former is composed of alternating sands, argillaceous sands, sandy shales, dark gray and brown shales, and occasional hard shells, aggregating a thickness of 650± ft. The Brown zone is 1450± ft. thick and is topped by a shale (The Brown Shale), with a distinctive microfauna that makes it a convenient key horizon. It is determinable either by paleontological examination or by interpretation of most drill-

when WATER is OIL



When coring an oil bearing formation with a water base mud, water from the mud infiltrates the core replacing oil.

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**Oil Saturation* *measured in cores at surface conditions ordinarily is interpreted to be residual oil saturation after the formation has been subjected to complete flushing by water invasion followed by shrinkage of residual oil and expansion of released gas which was originally in solution.*

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Signal Hill in the early days.

ing logs. The Wilbur zone is 1150± ft. thick, and consists of alternating shales, sandy shales and shells, with shales predominant.

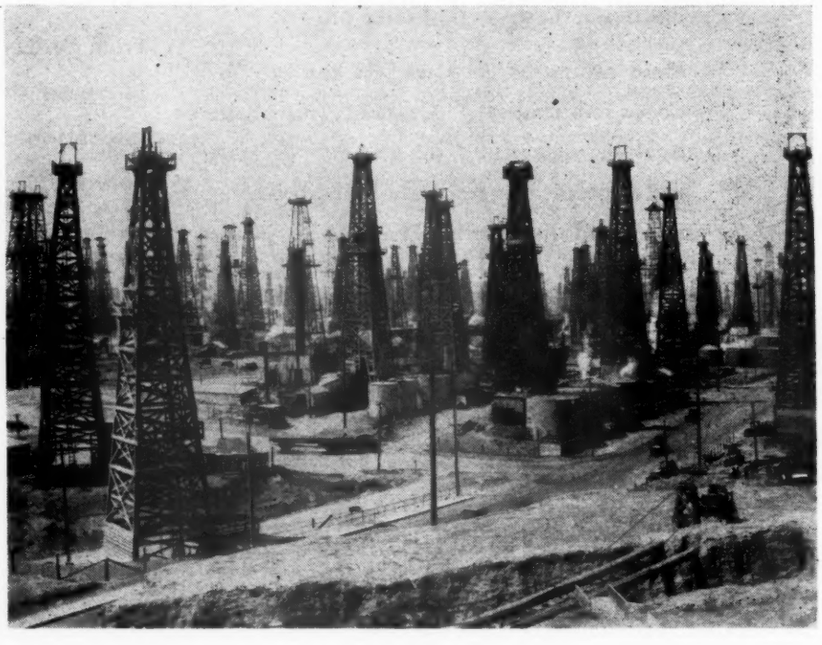
Below the lower 500-ft. section of the Brown zone, part of which is in the Miocene, are the Deep and De Soto zones. The former lies wholly in the Miocene, its top corresponding with the base of a distinctive shale marker. The Deep zone has been exploited to a thickness of 2500 ft., a total depth below sea level of about 7500 ft. The De Soto zone was discovered by the De Soto Oil Company's No. 1, south of Cherry Hill fault, and is also believed to be completely within the Miocene. Stolz says in his report in Bulletin 118 of the California State Division of Mines, that the total thickness of Miocene sediments in the field, though not determined, may exceed 15,000 ft.

An early report by H. M. Soyster and Martin Van Couvering gives a very complete account of the first projects, and all the pertinent data that could be accumulated from such a poorly controlled development. These authors cite the drilling of a test well, Bixby No. 1, in 1916 by Union Oil Company. The location was just southeast of the intersection of Wardlow Road and American Avenue. It was drilled to 3449 ft. without a consequential showing and was abandoned. Nothing further was done until the discovery well was drilled in 1921. It is interesting that early wells on the Hill were drilled almost to completion by rotary, and were then brought in by cable tools, this "to more accurately determine the nature of the formations penetrated, having especially in mind the presence or absence of water sands." The dual drilling practice was dropped before long and later ventures were carried on entirely with rotary equipment.

Emphasis is given to the fact that in early determinations of structure, the employment of the same drillers on a number of wells eliminated the confusion resulting from differing descriptions of the same formations and phenomena by different operators. Up to the time of the report, only the Shell Oil Company was in a position to follow this practice, so that data from their wells were unusually helpful in the first correlations. Core samples were, to begin with, representative of only small sections of the abnormally thick sands, but in the meantime, of course, all significant strata have been completely cored. Bit samples helped to show the incompleteness of other information, but were not in themselves too reliable. The same may be said of ditch samples, from which many wrong conclusions were drawn when the facts were not properly weighed.

The conductor casing strings in the pioneer wells were nearly all 500 ft. in length, but because of the loose nature of the surface formations this was soon found to be insufficient. When attempting to mud off the formations of the gas zone below the shoe of the conductor casing, tremendous quantities of mud were absorbed into the formations without shut-off. Sometimes the mud even worked its way up to the surface at some spot considerably removed from the well location. A sizeable quantity of gas was found in the upper zones, 1400 to 1800 ft., and a number of the wells had to be held in check with substantial mud col-

Top of the structure about the middle of 1928, showing the congested conditions. In this year the field made 62,457,103 bbl., the second best year in its history, the banner year being 1923 with 68,810,367 bbl.



To Pennsylvania's oil industry, America acknowledges a debt of gratitude. The Keystone state taught us to use petroleum and its products. "Drake's Folly" of 1859 led to the first "long distance" pipe line (5 miles of 2" pipe), the first trunk line (a 4" line from Oil Creek to Pittsburgh), and a trans-Allegheny line to carry this black gold to eastern markets. Until 1895 Pennsylvania ranked No. 1 in oil.

Today, in Pennsylvania's multitude of shallow wells there is strength. This state holds 12th place in production. Today its 83,230 wells are producing almost exactly at the state's 86-year average. Today its oil continues to make a major contribution to our national economy as it has for more than three-quarters of a century.

Pennsylvania expects to continue as an important oil producer for years to come. Through more than half its colorful oil history, Youngstown has served it with casing, tubing and line pipe. In the future, as in the past, oil operators, whether in Pennsylvania or any other part of the World, can continue to rely confidently on the dependable orange-banded pipe, drill pipe, casing, tubing and line pipe from Youngstown.

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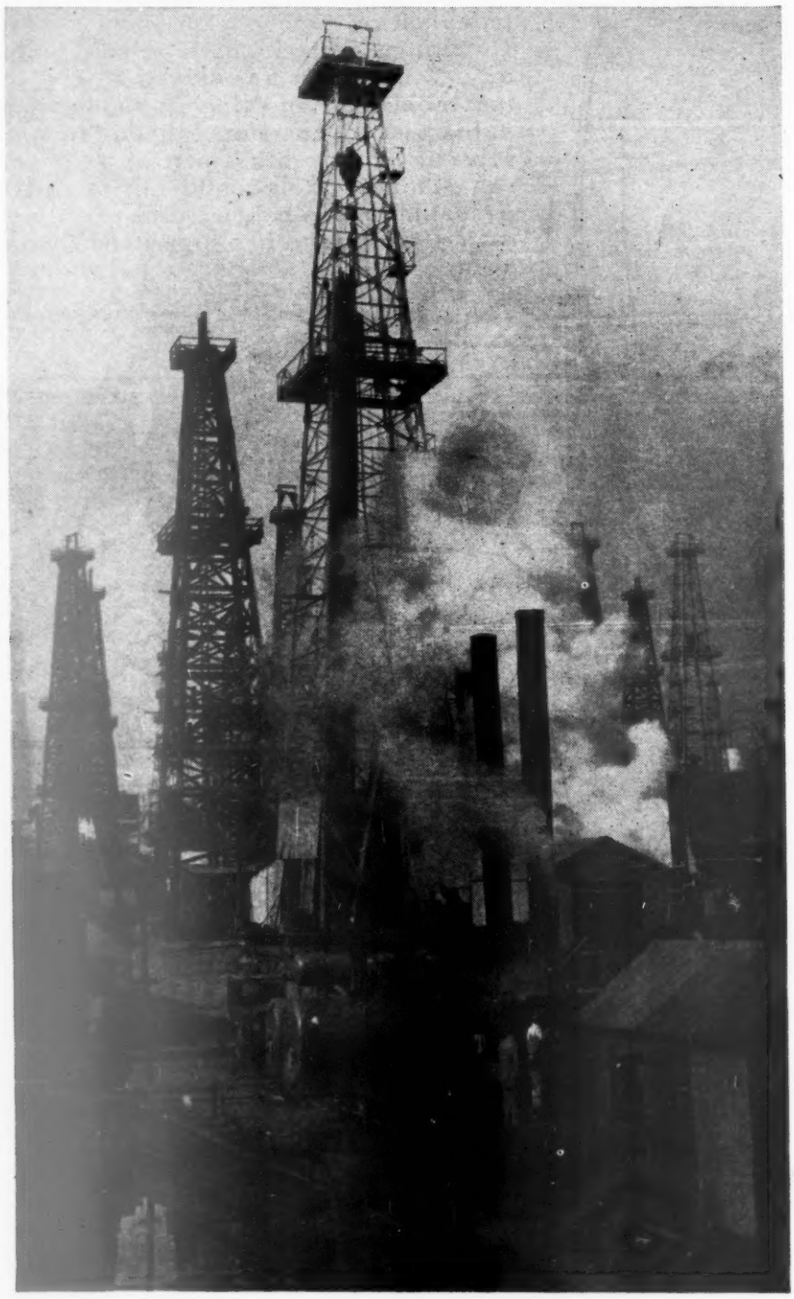
umns to keep them from coming in out of control. Shell Oil Company's Wilbur No. 1, with a water string cemented at 2085 ft.—total depth 2454 ft.—blew out with force enough to ignite the gas, by friction of ejected rocks against the casing. When the fire was subdued it was found that gas production was approximately 6,000,000 cu. ft. a day.

Another Department of Petroleum and Gas article by J. B. Case and Robert L. Keyes states that formations in the field were ideal for rotary drilling, being "sufficiently consolidated to stand up well—and yet soft enough to allow completion of a 4000-ft. well in 90 to 100 days." This compared with cable rig operation was a considerable saving in time, and coincidentally eliminated the need for several strings of casing. A 4500-ft. hole in this field and at this time could be completed by rotary with three casing strings, and have 6¼-in. casing for the oil string. With cable tools anywhere from six to ten strings were required, with a corresponding reduction in the ultimate diameter of the oil string. In addition, the primary objection to the rotary system had been that it did not permit accurate determination of the formations penetrated. With the introduction of the core barrel, however, that objection was no longer tenable.

The first wells drilled used 12½-in. casing to prevent caving of the loose material in the upper formations, and then used 8¼-in. for the water string. As production was recovered from increasing depths, however, larger conductor casing with 10 or 11-in. water strings were employed, so that the project might end up with a fair sized hole in the producing formation. In wells having only one water string, excessive damage occurred when deepening operations were undertaken, because of the friction of the drill-stem while drilling the great depths of hole required before landing the oil string. This led to the use of a secondary water string, cemented just below the shoe of the first water string, or somewhere between the first shut-off and the completion depth. The locale of the secondary cement job was fixed by the nature of the producing formations below the shoe of the first string, as indicated in adjacent completed wells. As an alternative to the method described, cement was pumped through the top perforations in the oil string—just below the shoe of the water string—and was forced up between the casings for a considerable distance. Often this string was landed before making all the hole, and the well was finished using a perforated liner below the shoe of the first oil string. In some of the deeper wells there was as much as 3000 ft. of perforated casing, when the above system was employed.

An interesting corner of the field some 10 years after discovery. It grew much too fast for orderly development, but its very lack of order stimulated interest in declination, deviation, and other aspects of scientific operation.



The Case and Keyes report, published in the beginning of 1924, gives three typical casing programs for different field areas, as follows:

Area "A"

Conductor—15½ in., cemented at 660 ft.

First water string—11 in., cemented at 2800 ft.±

Second water string—8¼-in., cemented at 3500 ft.±

Oil string—5 3/16 in., cemented at 5000 ft.±

(Perforated 3500-5000 ft.)

Area "B"

Conductor—15½ in., cemented 600-1000 ft.

First water string—10 in., cemented at 3500 ft.±

Second water string—8¼ in., cemented at 4300 ft.±

Oil string—4¾ in., landed at 4600 ft.±

Area "C"

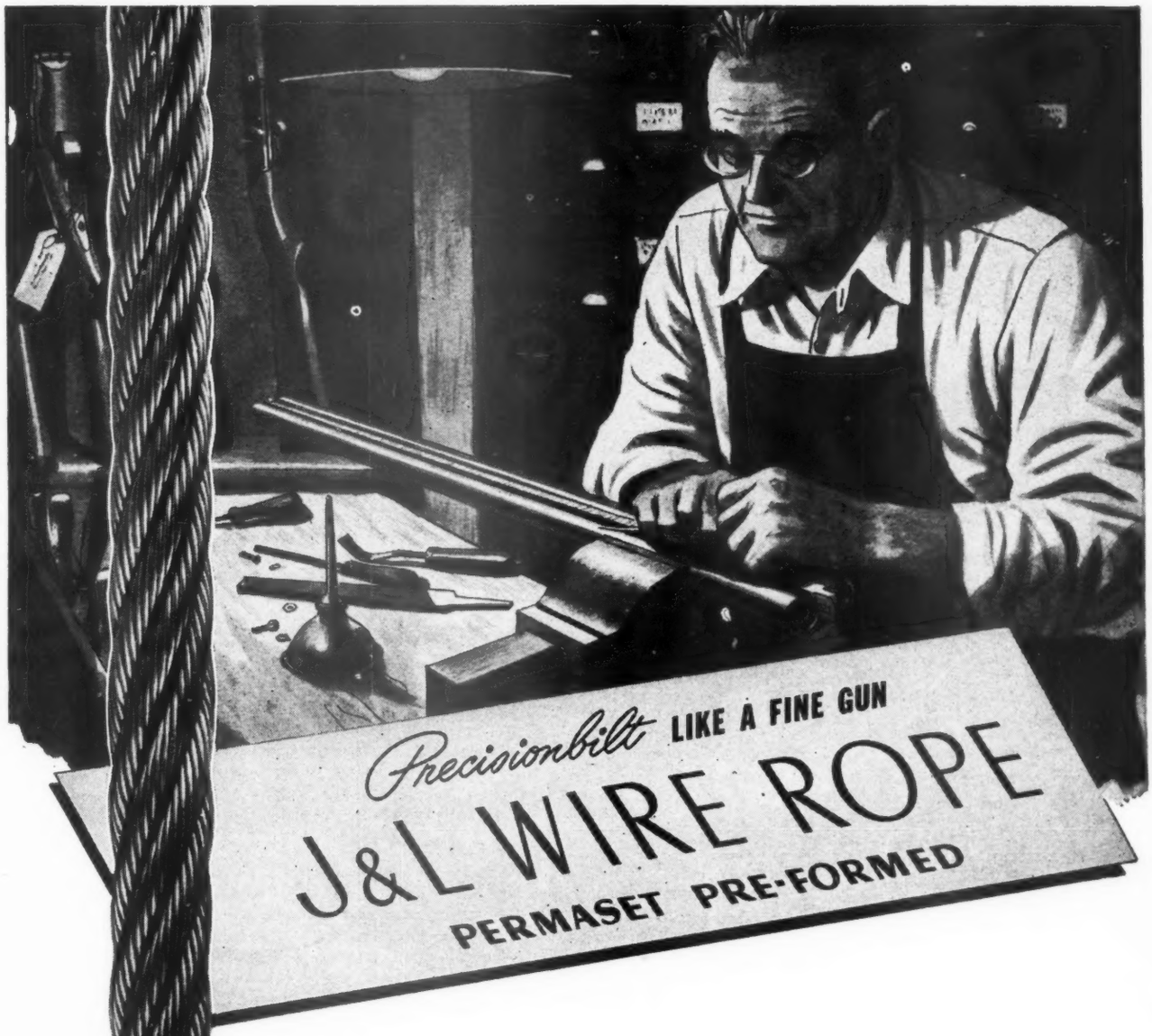
Conductor — 12½ in., cemented at 1000-2000 ft.

Water string—8¼ in., cemented at 4100 ft.±

Oil string—4 in., landed at 4500-5000 ft.

For the first two years of operation in the field, no particular trouble was experienced with edge water encroachment, but thereafter the water problem became somewhat acute. This was attributed in large measure to water entering the oil formations in wells that were in poor mechanical condition.

In the early stages of development, there was a considerable wastage of gas, partly because of failure on the part of some operators to realize the importance of the gas function and partly because



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Signal Hill in 1923 offered exciting spectacles. It was not uncommon then for oil wells to blow out, but it is almost unheard of nowadays.

of the lack of facilities for its treatment. There was, of course, no separate gas zone, the gas in its entirety being associated with oil. As much as facilities would allow was stripped in local absorption plants, but in a report by H. L. Musser, gas engineer of the Railroad Commission, on gas production and utilization, as of November 1, 1923, it was estimated that from a daily yield of 265,000,000 cu. ft., only 70,000,000 cu. ft. was utilized for domestic and industrial purposes. Only 175,000,000 cu. ft. of the total production was stripped of gasoline before being vented. In other words approximately 90,000,000 cu. ft. was never treated for gasoline recovery, and, including this, almost 200,000,000 cu. ft. was lost daily.

The field reached its oil production peak in October 1923, with a yield of 259,000 bbl., on October 24. At that time there were many wells drilling, and they were expected to hold the production rate at fairly constant level for a short time, but it seemed to be very generally predicted that by the beginning of 1924 the curve would take a decided dip. As of November 1, 1923, the field had produced a total of 72,000,000 bbl. of oil from 272 wells, 212 of which were flowing and 60 pumping. Average daily yield per well was 937 bbl. Recovery per acre (1120 proved) to this date was 64,285 bbl. The deepest well in the field was 5972 ft.; there were 28 producing wells idle, 200 active drilling, and 104 idle drilling wells.

In another Department of Petroleum and Gas report, made by D. C. Roberts, and bringing the field history up to the middle of 1928, reference is made to some surveys conducted by Alexander Anderson, which tend to show, as might be expected, that most of the deeper wells were very crooked, some having drifted more than 1000 ft. from the hole horizontally, and, thus, having a vertical depth much less than the drilled footage would indicate. During 1924, the proved area was extended slightly to the northwest of American Avenue, which obtained production from the Lower Brown zone. The percentage of pumping wells increased from 30 to 70, and production dropped from 225,000 bbl. daily to approximately 125,000. In the next year, there was further extension to the northwest, and by the end of 1925 there were 36 wells north of Wardlaw Road, each one averaging 250 bbl. a day.

An effort made early in 1925 to improve wells in the old part of the field by redrilling and plugging met with some success, but interest in this type of development waned as attention again turned to the northwest extension. Despite consistent exploitation, however, production gradually declined. One of the important developments of 1926 was perforation of the water string in Carson Oil Corporation's No. 13, in the northwest area. The 8¼-in. casing was perforated from 3220 to 3000 ft., about 200 ft., above the shut-off depth, and the well came in for 500 bbl. a day.

Some deep drilling was done in 1926, but the intense effort didn't get under way until well into the next year. It was in 1926, nevertheless, that Richfield completed its Haas No. 8 in the Lovelady section, southeast of the intersection of Willow Street and Orange Avenue. This well was drilled to 5317 ft., and came in for 2500 bbl. of oil a day. Two of the most interesting tests in the deep drilling campaign were Shell Oil Company's Martin No. 4, which was completed in April, 1928, at 7060 ft., with the oil string cemented through perforations at 5263 ft. This well flowed 1690 bbl. of oil a day and was the deepest producer to date. The best deep sand producer at the time was Richfield's Fry No. 3, at the southeast corner of Orizaba Avenue and Summit Street. Completed in February 1928 at 6402 ft., with oil string cemented through the perforations at 5362 ft., it flowed initially at a rate in excess of 4000 bbl. a day, and then dropped to a daily yield of 3332 bbl. of 29.3-gravity oil, with a cut of 2.2 per cent emulsion.

In May, 1928, there were 196 wells drilling to the deep sand, and the Department of Petroleum estimated that production would reach a peak of approximately 200,000 bbl. daily during June, when most of the wells were scheduled for completion. Nothing had as yet been done to find the deep zone in the so-called Cerritos area, that is, north of Wardlow Road extending north to Roosevelt Road and west to Lincoln Avenue, a tract of approximately 200 acres.

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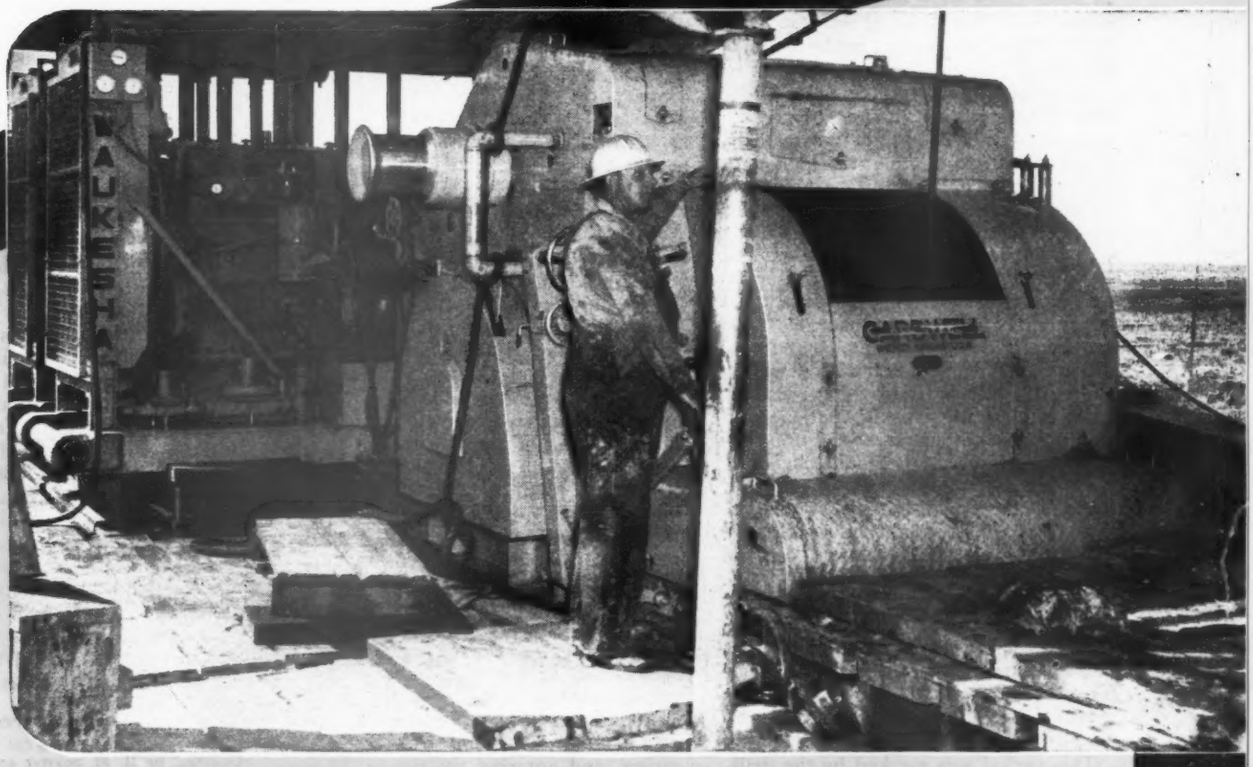

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It seemed likely from available data that it would be necessary to drill to at least 6000 ft. here, and operators were unwilling to risk too much on a deep venture until experience had proved the existence of a deep sand in the vicinity of Wardlow Road and American Avenue. Up to this time no well drilled had developed data on the basis of which it might be concluded that it would be useless to drill still deeper, and 10,000-ft. holes were popularly predicted.

In the next few years continued effort was maintained to determine the character of the deep zones, but it was found practically impossible to correlate formations more than 5000 ft. down. There seemed to be no distinctive marker strata, and operators were, therefore, unable to measure displacements due to faulting, and so could not obtain definite correlation between opposite sides of a fault. In a Division of Oil and Gas review of the field by Walter J. Crown, G. G. Pierce, and Paul J. Howard, issued at the close of 19_2, these facts are fully discussed and attention again called to the outstanding characteristics of the Long Beach field—"the great thicknesses of oil sands with interbedded shales—in some cases were unbroken by water sands for a thickness of 4500 ft. until intermediate edgewaters made their appearance."

Real headway was now being made with well surveying, and some very distressing facts came to light, particularly, as already indicated, that the footage of hole drilled was by no means indicative of the vertical depth of the hole. This more or less outlawed the meticulously prepared peg models that had been used to determine the depths and conformation of the oil reservoirs, and it negated many other charts and schemes for graphically depicting underground conditions. The surveys showed deviation and drift to an entirely unexpected extent, and all previous estimations and measurements of substrata had to be adjusted accordingly. It all had a beneficial effect on the progress of the industry, because oil men have an insatiable curiosity, and in this case, as usual, they immediately began to search for the factors that cause deviation and drift. One of them, improper weight disposition on the bit, resulted in the development of accurate and convenient weight indicators and other ingenious devices for either straightening out the hole or slanting it under controlled and predetermined conditions.

This period was marked by the drilling of a deep well, located right on the top of the structure, by Shell Oil Company. It was called Nesa No. 11, and was carried to a total depth of 9230 ft. It yielded some interesting and useful information but no oil, although some sand was cored in the horizon tested and there was sufficient evidence to justify the hope that deep production might still be found in the vicinity. Barren zones had previously been found in this area, but had proved not too pertinent with respect to adjacent wells, and then, of course, there was always the possibility that Nesa No. 11 had drifted considerably.

Signal Hill at a glance, as of June 1, 1946

Discovery well	Shell Oil Company, Alamitos No. 1
Date	June 25, 1921
Total proved acreage to date	1400
Total number of producing wells	1135
Total cumulative production (bbl.)	712,600,000
Total yield per acre (bbl.)	509,000
Current daily production (bbl.)	25,400

Signal Hill record of Shell Oil Company—the discoverer

Total acreage	314
Total wells drilled	266
Producing wells, current	235
Total cumulative production (bbl.)	148,300,000
Total yield per acre (bbl.)	472,293
Current daily production (bbl.)	4,900
Total cumulative natural gas (M. cu. ft.)	218,900,000
Current daily natural gas (M. cu. ft.)	5,900
Total cumulative natural gasoline (gal.)	517,000,000
Current daily natural gasoline (gal.)	45,000

A significant trend in this area was the acceleration of remedial work and redrilling, indicative of resignation to depleted returns, and a diminishing production rate. The perforation gun became a frequently used instrument for bringing in oil from cased-off formations. An example of what was accomplished by one such job was reported by the Division of Oil and Gas, as follows:

Casing record

12½ in., cemented at 720 ft.

10 in., cemented at 3520 ft., water shut-off.

8⅝ in., cemented at 4087 ft., water shut-off, bad at 3800 ft.

6¼ in., landed at 4562 ft., cemented through perforations at 40_2 ft.

4¾ in., landed 4084 to 4834 ft.

Total depth — 4834 ft.

The well in this condition was making 54 bbl. of oil and 390 bbl. of water, and had been wet for a number of years. The zone from which production came was known to be slightly wet, but not as wet as the yield indicated. A water locating instrument obtained a good reading at 4040 ft., from which it was deduced that the water was entering at the top of the perforations in the 6¼-in. casing. Knowing the entry point and the state of the hole, the repair program was rather simple: A cement bridge was pumped into the hole, with the top at 4050 ft., and cement was here squeezed out to fill the annulus between the 6¼ and 8⅝-in. casings. It was evident that the water was coming from a bad place in the 8⅝-in. casing, and entering the 6¼-in. at the top of the perforations. After treatment, the well daily produced 200 bbl. of oil and 10 bbl. of water. Shell Oil Company perforated its Wilbur No. 5 opposite shallower formation, from 4900 to 5200 ft., and was rewarded with a 3000-bbl. a day producer. Another successful job of this kind was Plymouth Oil Company No. 10, which, in 100 ft. of perforation, yielded more than 1000 bbl. a day of clean production.

Most of the activity for the next few years was of the type just described, and the industry garnered some very useful experience in the various phases of production engineering. In 1932, the field was again the leading state producer and looked as though it might hold a spot at the top, or nearby, for some time to come. Recovery had risen to 353,334 bbl. per acre since 1921, and total production was now approximately 447,001,278 bbl., with a maximum proved acreage of 1350.

In 1936, a new extension (The Hilldon area), located northwest of the productive territory hitherto exploited, and south of the Cherry fault, was added to proved acreage. The De Soto Company drilled a well in the Lovelady section in 19_8 that went down to 10,157 ft. and tapped a new deep zone, thereafter called the "De Soto" zone. This well was completed flowing for an initial yield of 300 bbl. a day of 28.9 gravity oil, with a cut of 0.3 per cent. The producing interval was between 9760 and 10,157 ft. and, despite its poor structural location, was regarded as an indication that profitable production might still be obtained at still greater depths.

In the years between 1939 and the present time, the field has settled down to exploitation of the northwest extension, and to a program of deepening, redrilling, and reconditioning the producing wells. Production has consistently dropped—from 17,000,000 bbl. in 1939 to an annual rate of about 9,000,000 bbl. currently. However, subsurface conditions do not yet preclude the possibility of finding deep sands beyond anything so far tapped. There is thus still the offchance that a new deep discovery may some day start another mild flurry. Shell attempted to get to the bottom of things in 1945 with a well that almost reached 15,000 ft., but it was a fruitless effort. Meantime, the field has without doubt been a substantial contributor to the national need in more ways than one. As of June 1, 1946, it has produced a total of 712,600,000 bbl. of oil from 1135 wells, and as already remarked is still producing approximately 25,000 bbl. a day. That in itself is a solid accomplishment, but the really substantial contribution that the industry derives from this 25-year-old adventure is an experience of incalculable value—an experience out of which have come new techniques and equipment, and a new understanding, that will profit not alone the industry but the world for many years to come.

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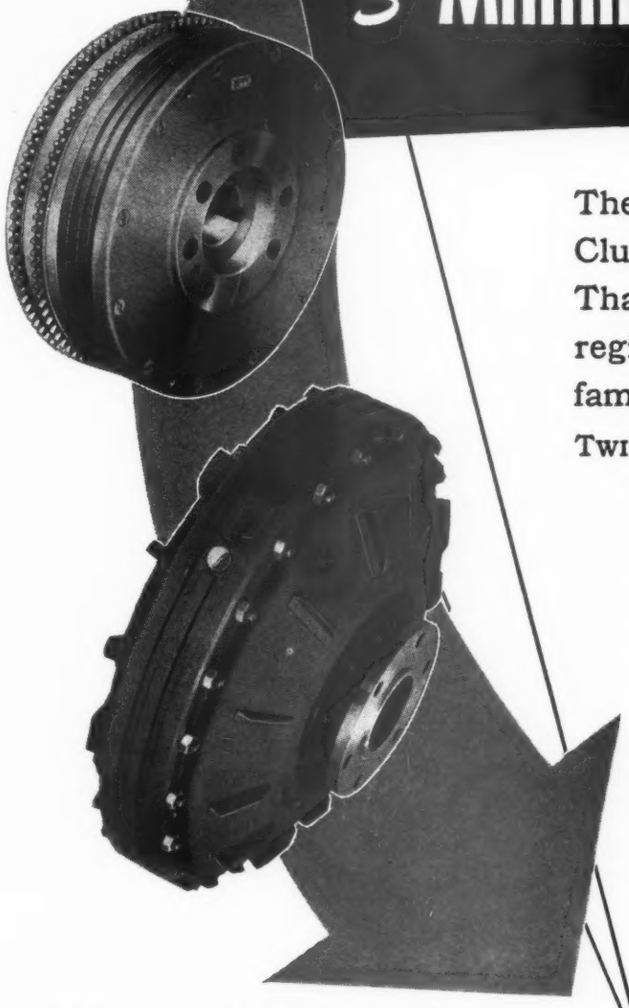

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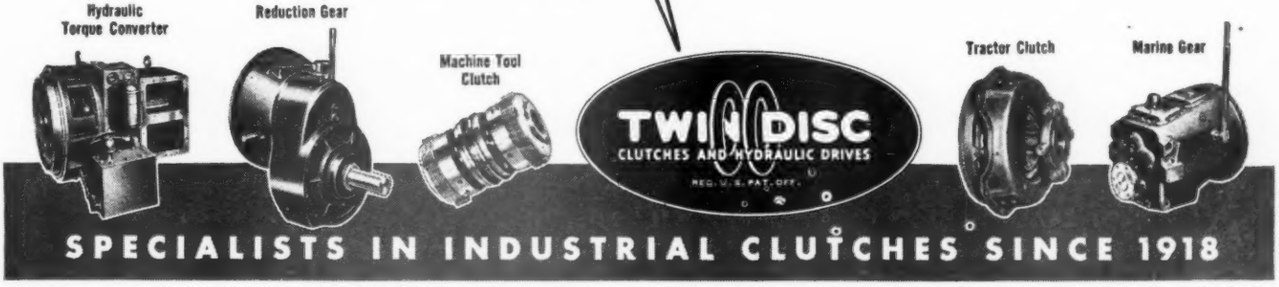

SPECIALISTS IN INDUSTRIAL CLUTCHES SINCE 1918

Selection and application of refinery instruments

By **ALFRED KRIEG***
Socony-Vacuum
Oil Company, Inc.

● **Preface.** The Paulsboro, New Jersey, refinery of the Socony-Vacuum Oil Company, Inc., covers an area of approximately 900 acres wherein 40,000 bbl. of crude oil per day are processed.

EXCLUSIVE

The larger major process units in the refinery include a thermofor catalytic cracking unit, Houdry catalytic cracking, thermal cracking, alkylation, gas recoveries, clearsol treating, benzol ketone dewaxing, and a bead catalyst manufacturing plant. General utilities include the power houses, water treating plants, and cooling towers. To operate these units effectively, more than 3500 industrial instruments are required throughout the refinery, which have an installed value of more than $1,000,000. With an investment of this magnitude, it is imperative that the responsibility for the selection, purchase, installation, and maintenance of these instruments and their allied components be vested in a competent organization. Such an organization must be staffed by technicians of varied skills. In addition to mechanical ability, the instrument technician must possess a good working knowledge of the duties performed by allied craftsmen and have a practical knowledge of general engineering procedures, as well as a detailed understanding of the operation of the process units.

● **Organization.** The Paulsboro refinery has established an organization as charted in Fig. 91. The foreman and assistant foreman of the instrument department are responsible for the efficient operation of the entire department, which is composed of three general sections: (1) The general engineering, (2) the mechanical maintenance, and (3) the electrical maintenance sections. All general engineering work, which includes orifice designs, valve sizes, instrument layout, etc., must meet with their approval before action is taken. The selection of proper instruments and materials for specific applications, planning work, and supervising all personnel are a few of the many responsibilities of the foreman and his assistant.

● **Engineering section duties.** The instrument department has established certain standards for the model and type of instrument purchased for a given installation, with materials for tubing, fittings, etc., and methods of connecting them, being fully specified. The instrument engineers cooperate with the process engineers in selecting and specifying

*Alfred Krieg is supervisor of Instrument Department at Socony-Vacuum's Paulsboro, New Jersey, refinery.

PART 7

Instrument Department

the proper instrument for an application when a new unit is contemplated. On some of the larger units, recently erected, between 500 and 600 instruments and components are required to operate the process efficiently. Many factors must be considered in their selection and installation. Engineering, with regard to control room layout, panels, and instrument layout on the panels to assure grouping of the instruments in process sequence, the ducts and supports for the tubing and fitting arrangement behind the panels, electrical switches, conduit and fittings, is laid out on the drawings. When the work is done by contractors, their preliminary prints are inspected, corrected, and approved when satisfactory.

When construction of a unit reaches the stage where instrument installation will begin, an instrument department engineer and a piping inspector are assigned to the job. The standards specify that instrumentation shall be supervised by an instrument engineer provided by the contractor. Cooperation of the engineers for both parties thus assure installation according to Socony-Vacuum standards.

Other engineering section duties cover the computation of all measuring devices, which includes complete calculations for measurement of fluids and gases by means of the thin plate orifice, flow nozzle and Venturi tubes in pipe sizes varying from ¼ in. to 36 in. Computations for wier measurement and pipe traverses with pitot tubes are also made. Computation and specification of valve sizes and material is another one of the engineering duties of the department.

Instrument specifications and data for all instruments from all sources are reviewed and approved in accordance with the department standards, and a complete library and file is maintained with the instrument companies' most recent literature, including instructions, price lists, and parts lists.

Complete records are maintained for proper identification of all instrument items in the refinery. Records of instrument purchase, specifications, installations and changes to range, location, and service are kept active. Recorder charts are analyzed and routine maintenance schedules prepared and checked.

Frequently, this section is called upon to obtain special data on equipment tests for other departments and also to assist in the design of special process or test equipment.

● **Mechanical maintenance.** The mechanical maintenance section of the department, in general, handles the periodic inspection of all instruments in the refinery, and the maintenance and repairs of all *mechanical* instruments, including flow meters, pneumatic controllers, weighing scales, dynamometers, regulators and diaphragm motor valves, pressure gauges, etc., as differentiated from *electrical* instruments.

Four groups comprise the mechanical maintenance section: (1) Instrument makers (2) instrument machinists, (3) instrument mechanics, (field men, instrument pipe fitters) and, (4) shift mechanics—under the general supervision of a section leader. Each of these groups will be discussed in detail.

● **Instrument makers.** The instrument department is often given the task of designing and fabricating special instruments and equipment for some specific application. Some of this equipment may be small devices, whereas others are of larger proportions. Patent rights have been granted for some of these devices. Under the supervision of the foreman or engineer, the instrument makers' duties are to design and fabricate this special purpose equipment. The work required in rebuilding, remodeling, and repairing of precision instruments is also performed by the instrument makers. Personnel of this section must possess high technical skill, and be able to visualize, design, and fabricate mechanisms as required.

● **Instrument machinists and shop mechanics.** Instrument machinists spend most of their time in the instrument shop and handle the repairs and worn parts replacement on all instrument equipment that are sent to the shop for major overhaul. They also handle some instrument repairs in the field, including routine maintenance on weighing scales and dynamometers, and must be well versed in the complete overhauling and repairing of the varied types of regulators, motor valves, and special equipment.

They are also called on to build special control valves and other mechanical devices and equipment. With the exception of those supplied with other equipment by contractors, the shop also fabricates all orifice plates to specifications of the instrument engineers.

The shop is well equipped to handle the intermediate and the heavier pieces of equipment. The facilities of this section include circulating liquid baths for temperature checking, and gauge-testing equipment consisting of testers and mercury columns for pressure and vacuum gauges. Portable and stationary water

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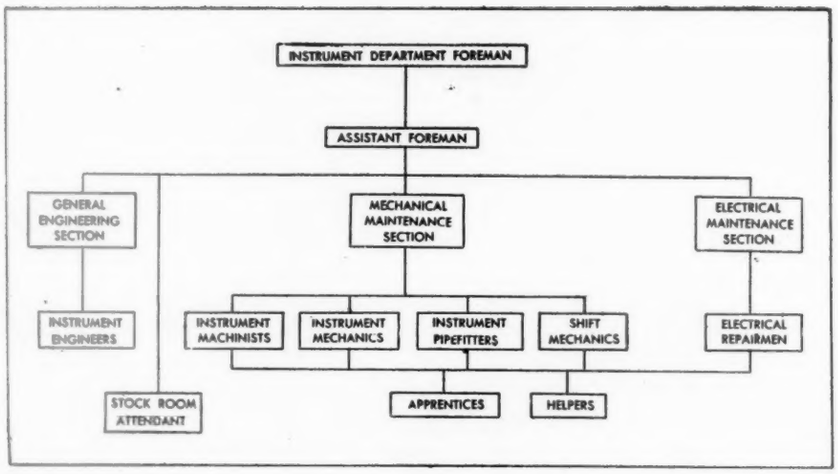


FIG. 91.

columns are used for checking differential type meters both in the shop and field.

● **Instrument mechanics.** The instrument mechanics are the men who maintain, repair, and check the instruments and equipment in actual operation in the field. Complete knowledge of installation methods of all types of refinery instruments is one of the prime requisites of an instrument mechanic. In the performance of his duties of trouble shooting or preventive maintenance, an understanding of the detailed principle of operation of every type and manufacture of instrument is necessary. In a refinery of this size, where several manufacturers supply a similar type of instrument, however, of their specific design for a given application, the mechanic must know every type and be able to repair and maintain each of them.

Along with a complete knowledge of all refinery instruments, the instrument mechanic must be familiar with the various processes with which the instruments are associated. An understanding of the process, as well as the control instrument, will assist the mechanic in solving any of the problems that may arise.

As the instruments are distributed over a wide area, it has been necessary to divide the refinery into zones in order to simplify maintenance work. One instrument mechanic is assigned to each zone, and is responsible to his leader for the proper operation and appearance of all instruments in his area. If the work, depending on conditions such as shut downs, remodeling, etc., is more than one man can handle, additional help is provided at the discretion of the leader.

The preventive maintenance work is one of the most important jobs handled by the field mechanics. Periodic inspection of every instrument is provided to prevent minor difficulties from developing into major problems.

A weekly schedule of work is prepared for each zone by the instrument engineering section, which lists the instruments to be checked and the type of inspection they are to receive. When the work is completed, the schedule is turned in and a new one is assigned.

Certain types of inspection can be made only when a unit is shut down, e.g., on orifice plates, control valves, thermowells, and pipe taps for pressure connections. These jobs are listed on the "unit shut down schedule" and when this occurs, the regular maintenance schedule is set aside and the shut down schedule is followed. Upon completion of the shutdown, the regular maintenance schedule is resumed.

Due to shut downs and other interruptions, it may require 13 months to complete a 12-month schedule. This extended inspection period, however, is not considered serious, as the main purpose has been accomplished, namely, that the instruments have received a periodic inspection, thereby forestalling many instrument and equipment failures due to lack of maintenance.

● **Instrument pipefitters.** In order properly to install the many types of instruments situated throughout the refinery, it was found desirable to include in the department a group of specially trained instrument pipefitters. These men are well versed in various instrument applications and therefore understand the requirements pertaining to proper installation methods. The proper sloping and grouping of lines, the proper connections to use at orifice flanges, the installation of supports and ducts for the tubing, and the general fabrication of the tubing to meet the specific requirements of the installation, must be completely understood by this group.

The instrument pipefitters are instructed in the correct selection of various types of valves, blow down legs, heating coils and tracing lines, and traps for installation on varied applications. They remove and assist in the overhauling of the larger size valves on shop repair work. They install instrument panels, orifice plates, and mount additional instruments on existing units where required.

● **Shift mechanics.** The instrument department personnel thus far described are on regular day work. To take care of the instrument problems that may occur at any time, four mechanics are employed on an around-the-clock schedule, so arranged that one man is on duty at all times.

These shift mechanics, unlike the regular day men, do not follow a regular inspection or maintenance program. Their time is primarily occupied with trouble shooting and emergency repairs throughout the refinery.

● **Electrical instrument maintenance.** The inherent principle of operation and the design of the electrical and electronic instruments, such as potentiometers, pyrometers, etc., present an entirely different maintenance problem from the mechanical type instruments. Different background and training is necessary in order to repair and maintain these instruments. For this reason, a separate electrical maintenance section, composed of men especially trained for this type of work, was formed. These men staff the precision laboratory, which is completely equipped with general precision equipment for testing all types of electronic and electrical instruments.

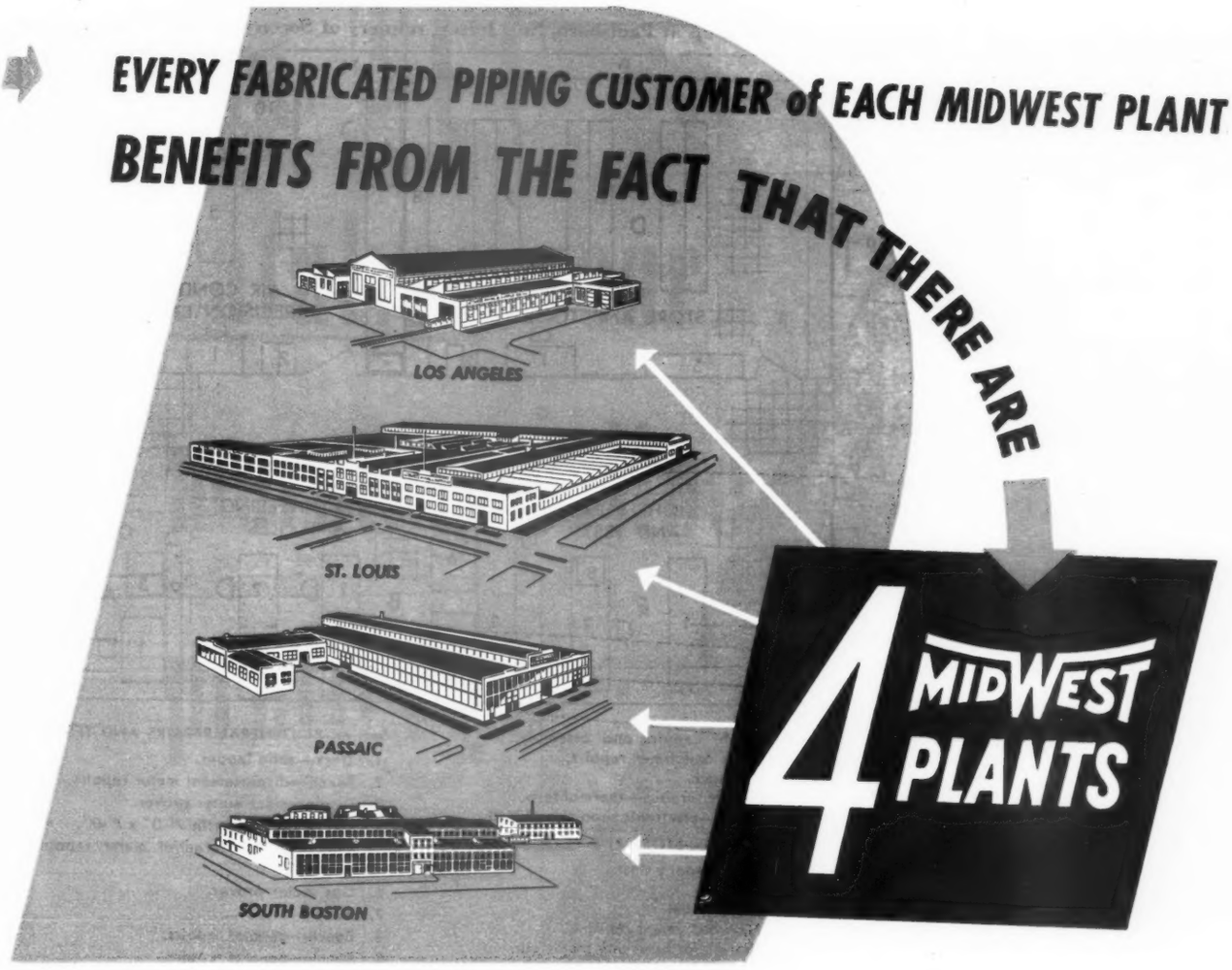
This section is responsible for the installation, maintenance, and repair of all electrical type instruments. The type of work performed by this section includes the repair and replacement of moving elements and their component parts, such as jewels, pivots, galvanometers, bearings, etc. When it is necessary to change the range of an instrument, the calculations and winding of resistance coils and the other required reconversions are performed by this section. Potentiometers are thoroughly overhauled, worn parts replaced, motors rebuilt and tested, and the complete instrument is standardized and checked before being replaced in the unit. Complete repairs to all electrical pH and CO_2 indicators and recorders are made by this section. Electronic measuring devices are repaired and maintained. The repair of all electric clocks and other timing devices are also the responsibilities of this group. They are frequently called upon to design, fabricate, and install special electronic apparatus for counting, timing, laboratory testing, and as safety devices on various types of equipment.

All types of thermocouples are fabricated and tested against a calibrated standard by means of an electric checking furnace where the temperature can be controlled and maintained at any desired degree. This assures a thermocouple of the highest degree of accuracy.

The inspection of thermocouple wells, which are installed in furnaces, transfer lines, towers, etc., to check for any signs of deterioration is performed during a scheduled shut down of a unit. The failure of a thermocouple well when a unit is on stream could mean a shut down of the entire unit.

● **Apprentices.** In order to select and train new personnel for the instrument department, an apprentice training program was established in 1939. This was found necessary due to the fact that the petroleum industry, in general, was becoming instrumentized with greater speed than trained men could be obtained to cope with the various engineer-

EVERY FABRICATED PIPING CUSTOMER of EACH MIDWEST PLANT BENEFITS FROM THE FACT THAT THERE ARE



Strategically located in various parts of the country, all of the four Midwest plants are of definite benefit to every Midwest customer.

Undoubtedly the most important advantage is the better piping that results from the continuous exchange of information and experience between the four plants. For example, if Passaic develops a new and valuable technique or method, the information is made available at once to St. Louis, Los Angeles, and South Boston. When Los Angeles finds a better way to control grain size in forged lap joints, the other plants are immediately informed. Regardless of which plant fabricates your piping, you get the benefit of the combined experience of all four plants.

Other advantages are greater flexibility in meeting delivery requirements . . . a better understanding of regional conditions . . . source of supply close to the job.

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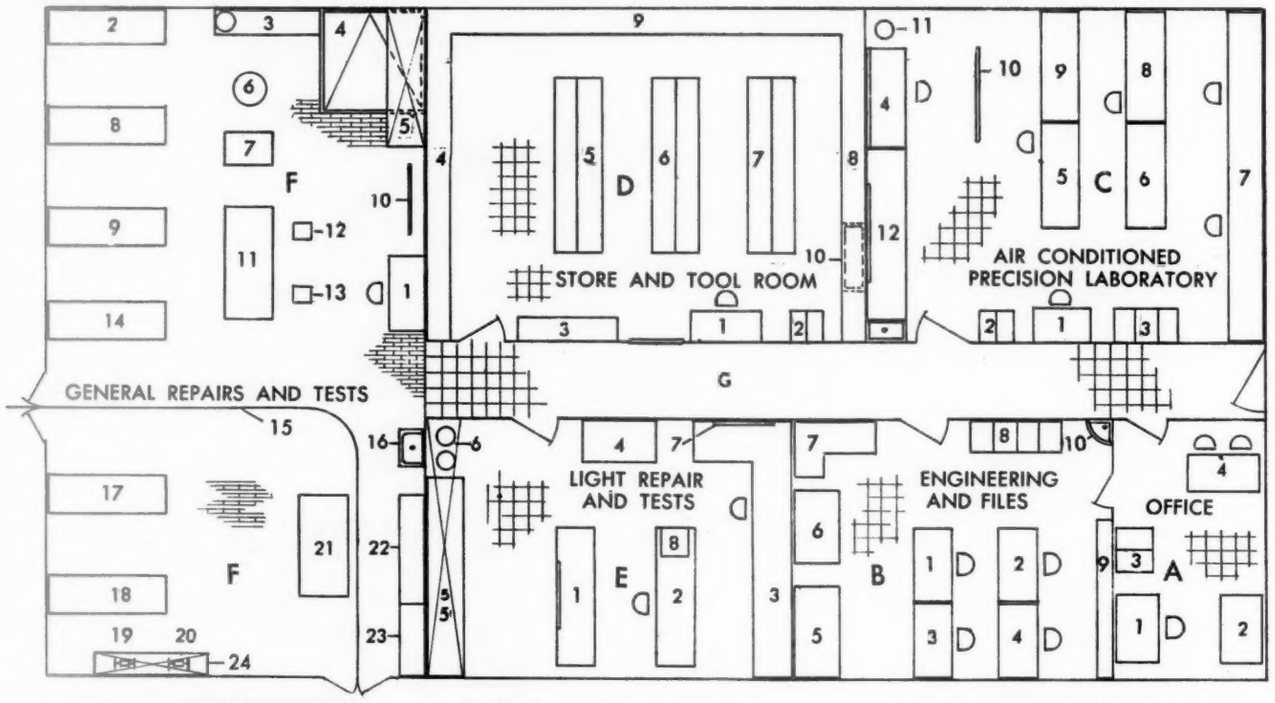
4 PLANTS ARE BETTER THAN 1

PIPING FABRICATORS AND CONTRACTORS

FIG. 92. Equipment layout of proposed instrument shop at Paulsboro, New Jersey, refinery of Socony-Vacuum Oil Company.



Section A—SUPERVISOR'S OFFICE

1. Desk.
2. Table.
3. Files.
4. Table—drawings.

Section B—ENGINEERING AND FILES

1. Desk—orifice calculations.
2. Desk—specifications, purchase and records.
3. Calculations—general instrument engineering.
4. Statistics, utilities charges, etc.
5. Drawing board.
6. Drawing file.
7. Catalog and record file.
8. Files.
9. Records.
10. Lavatory.

Section C—PRECISION LABORATORY

1. Desk—section leader.
2. Files.
3. Cabinet—precision tools and small parts.
4. Test bench—thermocouples, etc.
5. Bench—potentiometer overhaul and repairs.
6. Bench—special repair and assembly.
7. Bench—repairs and tests—CO_2 and pH equipment, etc.
8. Bench—repairs and assembly.
9. Clock and timer repairs.
10. Test rack.
11. Electric furnace—thermal tests.
12. Bench—electronic repairs and tests.

Section D—STORE AND TOOL ROOM

1. Storekeeper's desk.
2. File.
3. Tool cabinet.
4. New instrument storage.
5. Shelves for parts and materials.
6. Shelves for parts and materials.
7. Shelves for parts and materials.
8. Shelves for parts and materials.
9. Shelves for parts and materials.
10. Air conditioning unit for Precision Lab.

Section E—LIGHT REPAIR AND TEST ROOM

1. Bench—pressure instruments repair and test.
2. Bench—pressure instruments repair and test.
3. Test bench—special assembly and experimental work.
4. Work rack.
5. Thermocouple fabrication, thermometer repairs and tests, welding, etc.
6. Thermo-baths and testing equipment.
7. Test panel for controllers.
8. Bench drill.

Section F—GENERAL REPAIRS AND TESTS

1. Desk—shop leader.
2. Bench—displacement meter repairs.
3. Displacement meter prover.
4. Mercury catch basin 7'-0" x 7'-0".
5. Steel bench differential meter repair and test.
6. Gas meter prover.
7. Miller.
8. Bench—general repairs.
9. Bench—general repairs.
10. Test panel—water column tests.
11. Engine lathe.
12. Drill press—heavy duty.
13. Drill press—high speed.
14. Bench lathe.
15. Monorail—for hoist.
16. Laboratory sink.
17. Bench—regulators, etc.
18. Bench—regulators, etc.
19. Buffer.
20. Grinder.
21. Steel bench—heavy valves and equipment.
22. Lockers—heavy tools.
23. Test equipment.
24. Exhauster for buffer hood.

ing, installation, and maintenance problems. The war period increased the demand for these technicians and as many of our apprentices entered the military services, other men were hurriedly instructed to perform the work required. Our service men apprentices have returned 100 per cent and are continuing their training along with those in classes formed during their absence.

Candidates are selected from among the refinery employes, and from the helpers of the instrument personnel, with consideration being given to such qualifications as age, physical condition, interests and aptitudes, mental capacity to absorb and profit by instruction on the job and in the classroom, education, past history and accomplishments, home background, economic circumstances, and moral reputation and character.

Candidates are selected from applicants and are screened according to the above qualifications. Those who qualify are then given a general test and later an aptitude test. The candidates who are able to pass these tests with the required ratings are then placed in departments to which their individual aptitudes are best suited, for a probationary period of six months. During this time the apprentices are carefully checked for their fitness to continue the training, their practical work on the job attitude, and their progress is classrooms. They are paid a progressively increasing schedule of wages every six months, dependent upon satisfactory progress.

The apprentices work the same hours and are subject to the same conditions regarding overtime as the skilled instrument men, and have the status as a regular employe in regard to vacations, sick benefits, and other Socony-Vacuum policies.

Apprentices are under the immediate direction of the instrument foreman, who is responsible for seeing that they are properly routed through the predetermined work experience schedule, that they receive proper on-the-job training, and that performance standards are met.

A complete record of the progress of each apprentice, both on the job and in

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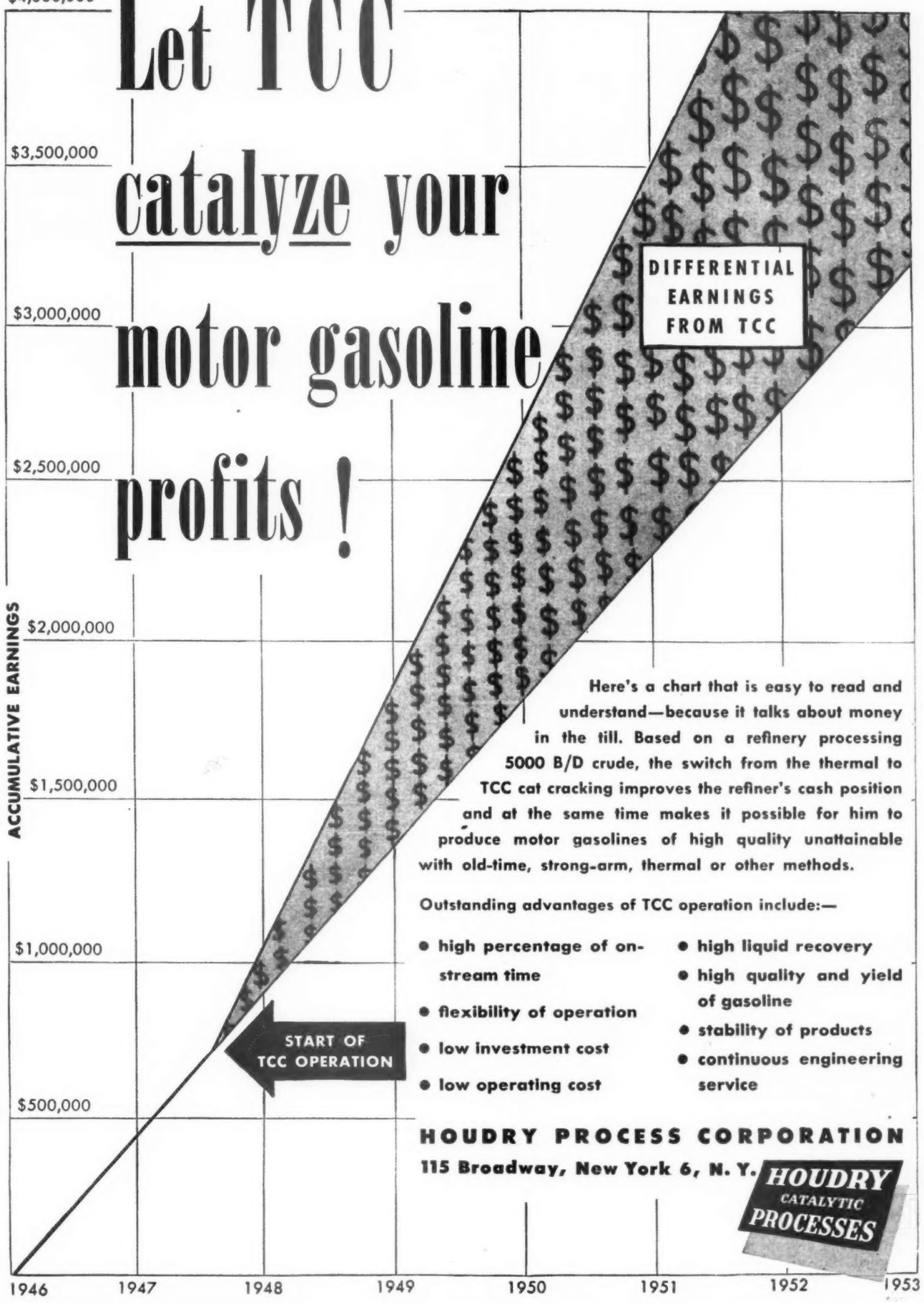

Here's a chart that is easy to read and understand—because it talks about money in the till. Based on a refinery processing 5000 B/D crude, the switch from the thermal to TCC cat cracking improves the refiner's cash position and at the same time makes it possible for him to produce motor gasolines of high quality unattainable with old-time, strong-arm, thermal or other methods.

Outstanding advantages of TCC operation include:—

- high percentage of on-stream time
- flexibility of operation
- low investment cost
- low operating cost
- high liquid recovery
- high quality and yield of gasoline
- stability of products
- continuous engineering service

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the classroom, is maintained. Frequent references are made to these records, and should an apprentice show lack of interest or exhibit inability to become a competent instrument man, various recommendations are made. He may be permitted to continue in a probationary status, required to repeat a specified process, or his apprentice agreement may be terminated.

Instrument apprentices are required to attend classroom instruction in subjects relating to his trade in the evening for a period of two hours per night, two nights per week, and 40 weeks per year. Courses of instruction are coordinated with the work training program. Such subjects are given as sketching and blueprint reading, applied mathematics, industrial economics, strength of materials, mechanics, etc.

Time spent in classroom work is not considered as hours of work, but apprentices are compensated, at straight time, for all regularly scheduled time spent in related study.

Upon the satisfactory completion of the requirements of apprenticeship, the company awards certificates setting forth the accomplishments and qualifications of the bearer. He also receives a certificate of completion awarded by the Federal Committee on Apprenticeship.

● **The new instrument laboratory.** The rapid expansion of the Paulsboro Refinery, with the inherent increase in instrumentation and personnel of the instrument department, has made it necessary to increase the facilities of the department in order to maintain the instrument equipment at its maximum efficiency.

Building plans for a new instrument laboratory have been completed, and at this writing the ground has been broken. It is anticipated that the building will be ready for occupancy in the near future. The sketch of the proposed shop covers a tentative equipment layout and the construction details. (See Fig. 92.)

The building covers an area of approximately 3500 sq. ft.

● **Office.** On the sketch, each section of the shop has been designated by a letter with section A being the supervisor's office. In addition to the desk, in this section, the office equipment includes personnel files, records, tables for blueprint study, etc.

● **Engineering.** In section B, the engineering details for refinery instrumentation is processed and records of all the department activities are maintained. In this section, process and instrument flow diagrams and prints are thoroughly analyzed, instruments selected, their location in the unit determined, purchase specifications analyzed, and the delivery dates and installation records filed. Records of all changes in range, operating conditions, orifice installations, along with instrument locations and services, are maintained. Orifice plate calculations, equipment transfers, and complete data on each instrument are accurately recorded. Here also the layout drawings for control room and other panels, piping, electrical equipment, orifice and transmitter locations, weather protection ducts, and supports for piping and instruments are developed.

Consumption of utilities by various units, departments, and sections is calculated daily from the records on flow meter charts, and a monthly report is sent to consumers and the accounting department. This is assigned to a planimeter operator, who, in addition to calculating the flow, also reports any discrepancies noted in the record of the flow or pressure pens or the integrator readings and reports them to the proper leader for assignment to the maintenance men. This section is also responsible for the records for the instrument maintenance schedule, which will be discussed in detail in another article of this series.

● **The precision laboratory.** Precision instrument repairs and calibration are made in the laboratory, section C. This section is air conditioned to assure constant temperature and humidity together with clean atmospheric conditions. The benches and equipment are arranged to use natural light to advantage. Artificial lighting in this section will be of the fluorescent type of the proper design, and suitably placed to assure illumination of the specified light intensity for the type of work performed.

Items C-1 and C-2 are the section leaders' desk and file cabinet. A steel cabinet, C-3, is used for small precision parts such as jewels, pivots, small contacts, springs, special small tools, repair and calibration equipment made up for test work. A bench and panel, C-4, comprises a K-2 potentiometer and other instruments used for the calibration of thermocouples, or other sensitive elements and temperature controls. The electric furnace, C-11, is also controlled from this panel. Thermocouples on test are connected to a multipoint switch on the panel. From this point, temperatures may be taken from an indicator, or by switching may be recorded on an electronic recorder. The recorded range may be changed by the manipulation of toggle switches to obtain the range best suited to the test. The wiring and switching arrangement also permits this recorder to be used on tests conducted on other benches in this section and from the test rack C-10.

Potentiometers and all electrical types of temperature measuring instruments are overhauled and calibrated periodically in the shop. Each part and unit is carefully inspected and replacement made where necessary. Slide wires are checked for calibration, galvanometers tested, rotary switches thoroughly cleaned and checked for wear, electrical tests made on all circuit wiring, and the motors cleaned and lubricated. When reassembled, the instrument is checked for calibration on the test rack for a period of 48 hr. When temperature controllers are overhauled, the control apparatus is cleaned, checked, and tested also. Generally, the overhaul work on potentiometers is handled at bench C-5. Motor overhauling, on the exchange system where small instrument type motors are removed in the field and replaced by one previously overhauled, and repair and assembly work on other types of instruments, are also completed at this bench.

The department is required to make tests on special equipment or to carry on experiments of a mechanical or electrical nature. This is usually performed at bench C-6. The field mechanics assigned to the electrical section frequently bring the parts of instruments for repair or replacement to the shop. Bench C-8 is generally used by these men or for other miscellaneous jobs.

Complete facilities for CO_2 and pH instruments of the electrical type are set up at bench C-7. Gases and chemicals of certified values are available for test runs and calibration checks. All types of electrical resistance tests are also made at this location. Slide wires, thermohms (resistance bulbs) for temperature measurement are checked and resistances for all purposes are made up when necessary. Accurate calibration of electrical instruments is assured by using a type R spotlight galvanometer, connected through the previously mentioned switching arrangement.

● **Stockroom.** A stockroom for instruments and equipment parts, tools, and material is designated as section D on the drawing. A complete inventory of spare parts is maintained in this stockroom. As new instruments are installed throughout the refinery, a survey is made to determine which parts should be carried in stock, the quantity of which is based on the number of instruments of this type in operation and the anticipated wear or breakage.

Tools for handling any job — from work on the small jewels or hairsprings to a 10 in. pipe line or a large diaphragm motor valve—are part of the inventory. With few exceptions, instruments are connected with steel or copper tubing, and all tools for cutting, forming, straightening, and flaring the various types and sizes of butting are stocked by the toolroom. Cabinet D-3 and part of shelves D-4 are used for tool equipment storage.

Bins and shelves designated as D-5, D-6, D-7, D-8, D-9, and a part of D-4 are used for various material and parts storage. Each rack has a letter and each bin a number. With the bin number is also stenciled the material or the instrument name or part number as designated in the manufacturers' parts list. Any part or material item can be easily found by consulting the indexed list, which designates the location, bin number, etc.

Instrument types have been standardized as much as possible in order to simplify the inventory problem.

● **Light repair and assembly.** Light mechanical repairs and assembly, mechanical experimental work, pressure and controller testing, thermometer tests, and light welding and brazing of small parts are performed in section E.

On bench E-1, all pressure instruments are repaired and tested. Pressure gauges and recorders, pneumatic con-

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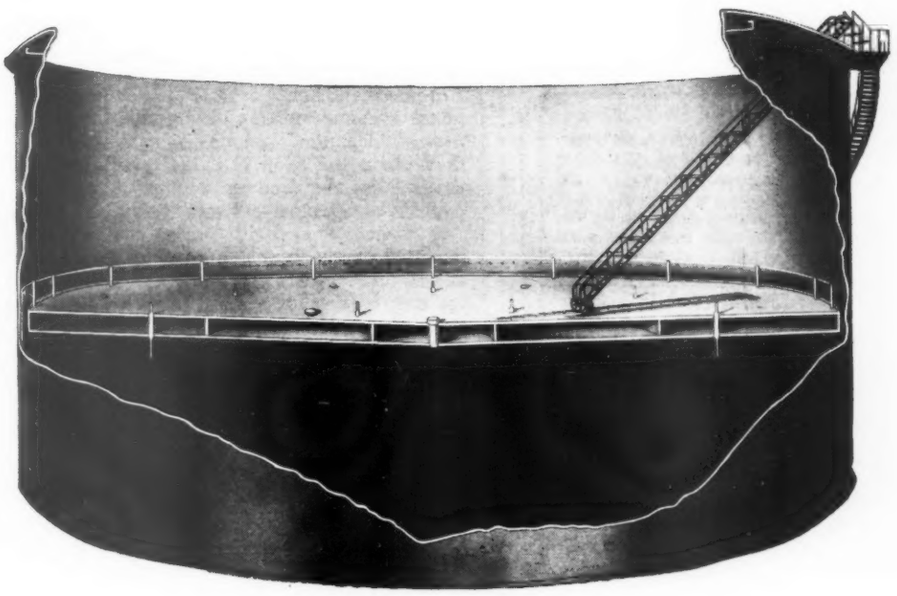
An improved double deck floating roof of simplified construction with positive vapor pressure seal.



The Graver Pontoon Floating Roof is ideally suited for vapor saving storage under the following conditions:

- For finished products in tanks too isolated for practical manifolding or in tanks where excessive differences in filling and withdrawal may exist, such as a water terminal.
- For "sour" crudes. The roof lies entirely upon the surface of the liquid and eliminates any vapor space and the possibility of corrosion.

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1. Double Deck insulates stored liquid against boiling.
2. Vapor tight seal is doubly actuated by springs *plus vapor pressure.*
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5. Screened open drain. Pipe drain optional.
6. Adjustable supports.
7. Seal composed of 16 gauge heavily galvanized or stainless steel continuous shoe and long lasting synthetically treated fabric.
8. Simplified construction.

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The Bourdon tube is the actuating element of the control. It is the oldest known, tried and proven element, having been used in gauges for many years.

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The outside double adjustment with the calibrated dial and pointers is a convenient feature, making it very easy to set the required operating range, plainly visible on the dial. All guesswork is eliminated.

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The glass face on the cover permits seeing the entire operation of the control in plain view. One can always tell whether the switch circuit is open or closed, a great convenience whenever servicing becomes necessary.

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trollers, small relief valves, and regulators are overhauled and repaired. Break down and hydrostatic tests are conducted on various equipment parts and on materials pertinent to instrumentation.

On the panel shown on this bench are mounted the test and calibration instruments used as standards. Water and mercury columns are used for low pressure indicating and recording instruments. It is possible to make tests pneumatically on equipment where service requirements prohibit the use of oil, or on the delicate diapraghm or bellows type actuating mechanisms of low range pressure instruments. Dead weight testing machines, several of which have been modified to suit special jobs, are used as standard testers. "Check gauges" used by the field men are tested daily for accuracy on these machines and they are also used for general test work.

Beneath the E-1 bench a small vacuum pump is connected to a piping manifold from which the vacuum is available throughout the shop. To this manifold the line for the vacuum column on the panel is also connected.

A bench type drill press, E-8, is mounted on the bench, E 2, for general use in this section. The bench space remaining is used for general pressure instrument repairs and for experimental work involving pressure tests.

When it is necessary to modify existing instruments for changes in operating conditions, or when additional features to instruments or equipment are desired, this work (unless entirely electrical) is accomplished at bench E-3. Recently, 12 recording temperature controllers were converted to time cycle controls. The cams, control arm follower, and combination cam adjuster—chart knobs and control linkage were designed, made up, and calibrated in this section. Special fabrication and assembly, and experimental work are also handled at this bench.

E-4 comprises a work rack where repair or finished jobs are stored. E-5 is a bench on which repairs and tests of varied types of temperature measuring devices are made (electrical instruments excepted). The baths, E 6, are equipped to obtain normal check temperatures by use of the steam, water, and air utilities available in this section. Welding and brazing, silver soldering, and soft solder work are done at this bench also. Thermocouples are made up, the tips welded, insulated, and marked for quick identification. Checking on this work is done in the laboratory at bench C-4, as previously mentioned.

This bench is also equipped with various types of equipment for holding instruments in position while undergoing repairs or check, and with many special jigs and tools.

● **General repairs.** The general repair section, F, is equipped for heavy repairs on valves, etc., or any machine work that may be necessary. A monorail, F-15, for hoisting blocks is installed to be accessible at two doors of the shop, and to service the heavy work bench F-21 and the engine lathe F-11. This equipment is used primarily for handling large sized diaphragm motor valves. F-21 bench is of heavy steel and angle welded construction with jigs and strapping arrangements to accommodate the valve body castings. Complete overhauling of diaphragm motor valves and the replacement of parts, including diaphragms, plugs and seat rings, is performed at this bench. When necessary the plugs are reshaped and fabricated from special materials for use in corrosive and other unusual services.

Smaller sized valves and regulators are repaired at benches F-17 and F-18. High pressure air is available at these benches as well as all other benches in the section for test purposes, etc. The equipment for testing the action of the valves and other devices and the heavy tools required for the repair work are stored in lockers F-22 and F-23.

Items F-19 and F-20 are a grinder and buffer for general use, with an exhauster hood and fan, F-24. Use of the buffer produces a factory finish for reconditioned or repaired parts or for special parts that are made for instruments.

Benches designated F-8 and F-9 are used for repair and assembly and occasional use of field men. F-14 is a bench type engine lathe with a 9 in. swing; F-11 an engine lathe, 14 in. by 9 ft., to accommodate some of the heavier parts; F-12 a high speed drill press and F-13 a low speed drill press, and F-7 a miller designed for instrument repair work.

Item F-2, the displacement meter bench, is built and equipped for handling repairs and general overhauling of these measuring devices. The various types and sizes, for measuring all fluids, are cleaned and repaired at this bench and when ready for calibration, are set up in the prover, F-3. Each meter is checked for accuracy at a minimum of two rates of flow, depending on the service, and up to five meters may be tested on one prover run.

The recovery basin, item F-4, is designed to collect and make possible recovery of mercury from the bench F-5 or mercury spilled or drained from meters. The bench is of all-steel welded construction with edges flared up to form a pan, which is drained at the low end. A filter and purifier is provided at one end of the bench where mercury may be reconditioned. This operation is done only in accumulated lots due to the process involved and for reasons of safety, and for this reason, also, an exhauster hood and fan are provided over the bench. A perforated tray provides brackets for mounting manometers and transmitters and facilities for cleaning and complete overhaul are available. Connections to the test panel, F-10, situated at bench F-5, are made up to the meter or meters. The columns for various liquids are usually pneumatically operated, but may be operated on a vacuum when more practical, depending on the type of meter.

★ ★ ★

(The eighth installment of Mr. Krieg's article will be published in an early issue.)

Airborne magnetometer

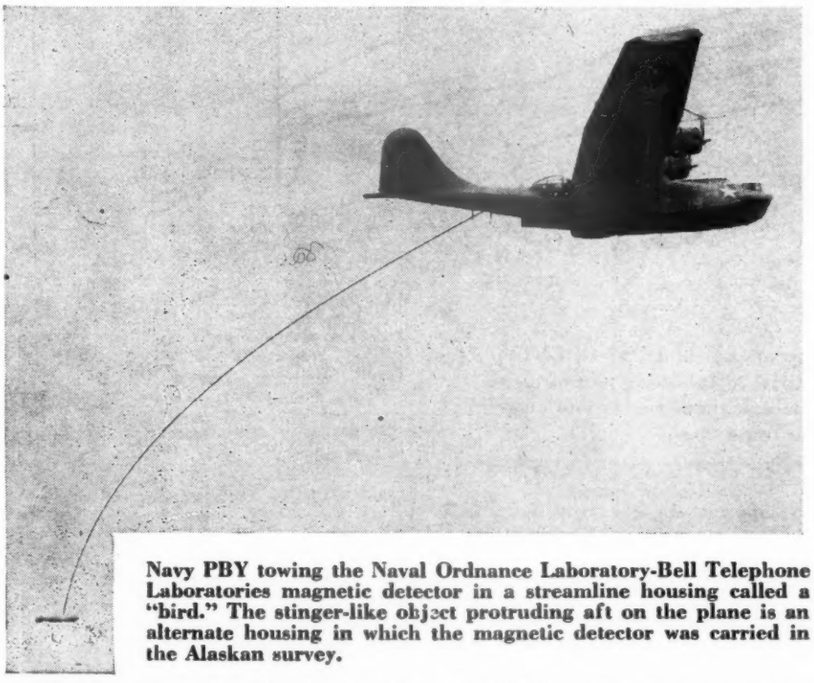
By **JAMES R. BALSLEY, JR.**, Geological Survey,
United States Department of the Interior

Rapid geophysical surveys made possible by adaptation of instruments used to detect submarines.

In 2 Parts—PART I

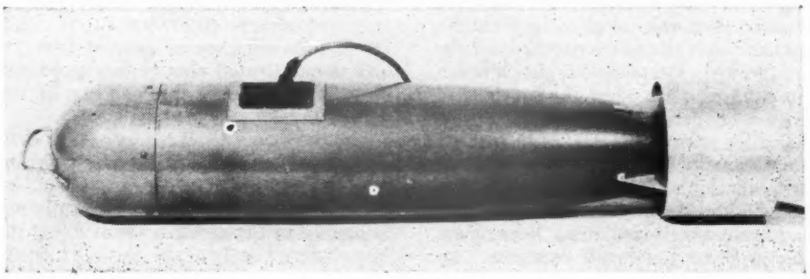
● **Introduction.** During the last few years a number of scientists and engineers have combined to produce one of the great advances in the field of geophysics—the development of a practical means of making accurate magnetic surveys from the air. Designed originally as a military device for locating submarines, the airborne magnetometer has been further developed into an instrument of tremendous peacetime application. This has been accomplished by the cooperation of several diversified government agencies and private organizations whose electronic engineers, military physicists, photographic engineers, geologists, and geophysicists all joined to develop equipment that could not have been designed and perfected otherwise.

Until now military security considerations have prevented the release of any specific information regarding the equipment or its use. During the period of development of the equipment, experimental surveys were made of more than 40,000 square miles, from the Arctic Ocean to the Gulf of Mexico. Surveys have been made from heights of 150 ft. to 14,000 ft. above the ground. A wide variety of magnetic and geologic environments have been mapped from the low magnetic gradients encountered in oil prospecting to the high gradients associated with magnetic iron ore deposits. In all cases and under all conditions the airborne magnetometer has shown that it is unsurpassed as a means of making magnetic reconnaissance surveys.



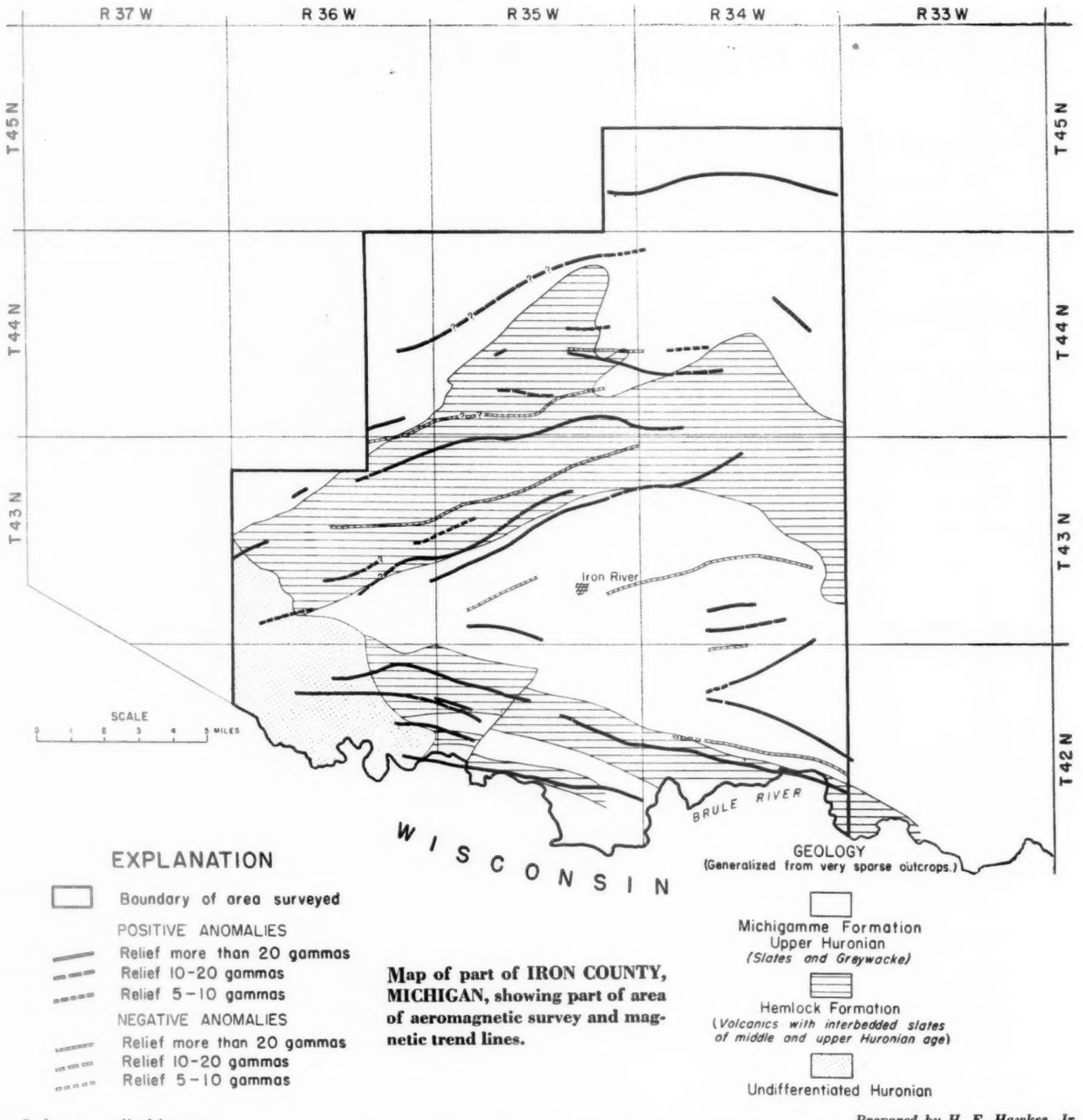
Navy PBY towing the Naval Ordnance Laboratory-Bell Telephone Laboratories magnetic detector in a streamline housing called a "bird." The stinger-like object protruding aft on the plane is an alternate housing in which the magnetic detector was carried in the Alaskan survey.

"Bird" or streamline housing used by Naval Ordnance Laboratory to tow the magnetic detector at a distance from the plane to eliminate disturbances.



● **History.** The original Navy magnetometer was developed from an idea submitted to the Navy in World War I by the Department of Terrestrial Magnetism proposing the magnetic detection of submarines by aircraft. Important among the technological advances that made the airborne magnetometer possible was the discovery, published by German scientists in 1936, that accurate magnetic measurements could be made by employing the principle of the fluxgate or flux valve. Under stimulus of the submarine menace along our coasts, electronic engineers and physicists of the Naval Ordnance Laboratory, Bell Telephone Laboratories, and the Airborne Instrument Laboratory of National Defense Research Council, designed highly sensitive antisubmarine devices called Magnetic Airborne Detectors. These consisted of self orienting fluxgate detectors designed to measure only the transient anomalies caused by a submarine. In addition, the Gulf Research and Development Company devised a gyro-stabilized magnetic detector that saw limited antisubmarine use early in the war. Spurious signals from geological conditions are partially removed by a series of filters. The MAD (magnetic airborne detector) designed by the Naval Ordnance Laboratory and Bell Telephone Laboratories (the AN/ASQ-3A) was nevertheless equipped to measure total magnetic intensity. The initial geophysical measurements were made with this detector by the Naval Ordnance Laboratory in early 1943.

Late in 1942, H. E. Hawkes of the U. S. Geological Survey learned of the existence of this magnetometer and recommended that it be adapted to use in geophysical exploration as soon as possible. In December, 1943, J. R. Balsley of the U. S. Geological Survey, who also recognized the potential importance of the instrument for geophysical exploration, initiated discussions with Dr. L. H. Rumbaugh of the Naval Ordnance Laboratory on modifications necessary to adapt the magnetometer for mapping extensive areas. These included some improvements in the electronic equipment, but the principal developments were concerned with aerial navigation and the determination of the plane's position for geophysical mapping.



Map of part of IRON COUNTY, MICHIGAN, showing part of area of aeromagnetic survey and magnetic trend lines.

Geology generalized from geologic map of Iron County by L. P. Barrett, F. G. Pardee, and W. Osgood.

Note: Area covered at three elevations: 300 ft., 600 ft., and 900 ft.; Data for this map taken from 300 ft.—level flight.

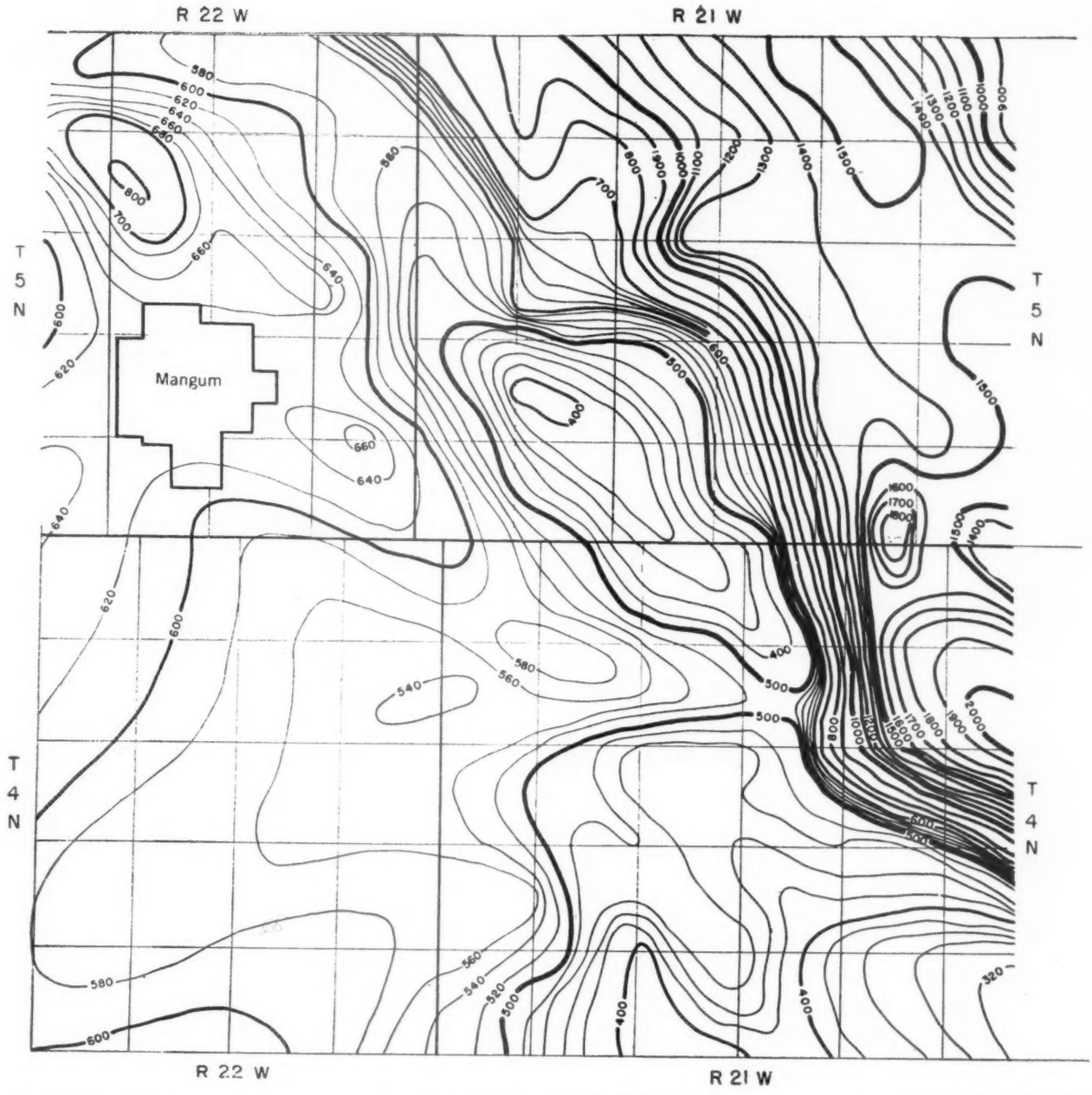
Prepared by H. E. Hawkes, Jr., from magnetic data compiled by J. R. Balsley, Jr., H. Jensen, J. P. Fitzsimmons, M. E. Hill, V. S. Neuschel, 1946.

PLATE 1. Geophysical investigations Map No. 3.

The equipment was made available to the U. S. Geological Survey through Comdr. Joyce of the Bureau of Aeronautics and a project was set up in Naval Ordnance Laboratory and Bell Telephone Laboratories for its modification and installation. Homer Jensen of the Naval Ordnance Laboratory was placed in charge of this work and has continued to translate the requirements set up by the geophysicists of the Geological Survey into further improvements in the installations that have been engineered by the Naval Ordnance Laboratory and Bell Telephone Laboratories. The modified magnetometer was installed in a single-engine Beech biplane contributed by Aero Service Corporation of Philadelphia, who also supplied the services of their most experienced pilot.

In order to gain experience in making detailed magnetic surveys from the air and to check the accuracy of the equipment, flights were made in April, 1944, along three traverses near Boyertown, Pennsylvania, previously surveyed by Geological Survey ground crews. These flights of the airborne magnetometer were completely successful in checking the results of careful ground surveys, and demonstrated clearly the speed, accuracy, and broad applicability of the equipment.

On the basis of these results it had now been proved possible to fly over unknown territory at great speed and, by proper interpretation of the records obtained from the airborne instrument, to infer what lies beneath the surface of



Traced from isogam map of Gulf Research and Development Company, based on its surface magnetic data.

VERTICAL MAGNETIC INTENSITY
Mangum, Oklahoma
Observations taken at ground surface.

Contour interval: to 700 gamma, 20 gamma; above 700 gamma, 100 gamma. Datum independent of that used in aerial survey.

PLATE 2. Geophysical Investigations Map No. 3.

the earth. The plane was flown to Iron River, Michigan, and in May and June of 1944 a systematic survey was made of 1500 square miles of wood and swamp land. Here, too, the results were successful—proving the usefulness of the airborne magnetometer for reconnaissance geophysical exploration of large areas.

Further work in a single-engine plane was deemed unsafe, but no twin-engine plane was available at that time for the continued use of the Geological Survey. In August, 1944, this situation was brought to the attention of Commodore W. G. Greenman, Director of Naval Petroleum Reserves, who recognized the applicability of the equipment for making surveys in Naval Petroleum Reserve No. 4 in northern Alaska. With a view toward furthering the development for that purpose, he arranged for the Navy to supply a twin-engine Beechcraft SNB-1 for further experiments, and set up a project with NOL and BTL for the continued development of the equipment.

New equipment incorporating improvements indicated during the Michigan work was installed by the Naval Ordnance Laboratory and during the winter test surveys were made of typical low-gradient magnetic anomalies associated with oil structures. While Naval Ordnance Laboratory and Bell Telephone Laboratories made further improvements indicated by this work the U. S. Geological Survey used the SNB to make a very profitable survey of the iron-bearing area of the Adirondacks.

The complete system of equipment next was installed in a Catalina amphibian PBY-5A at the Naval Aircraft Modification Unit, Johnsville, Pennsylvania. Manned by U. S. Navy pilots and mechanics, Naval Ordnance Laboratory electronic engineers, and Geological Sur-

Now...

Unbelievable as it is, the petroleum industry, the world's third largest business, has never had a single-volume source from which its members could obtain all statistics and operational data for quick reference. When statistical data were needed (daily in many departments) it has been necessary for the busy executive to search through a wide variety of conflicting sources for facts and figures — sometimes reliable, sometimes questionable, too often unobtainable.

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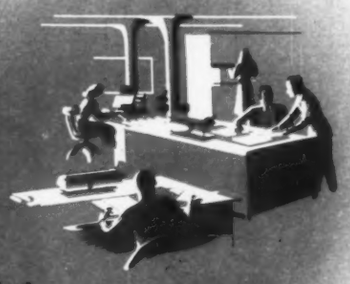

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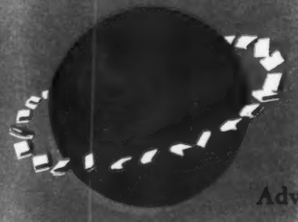

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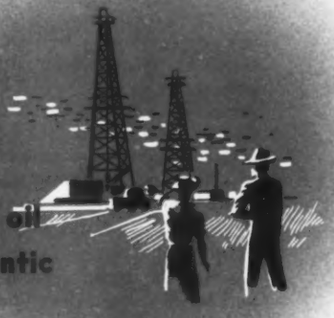

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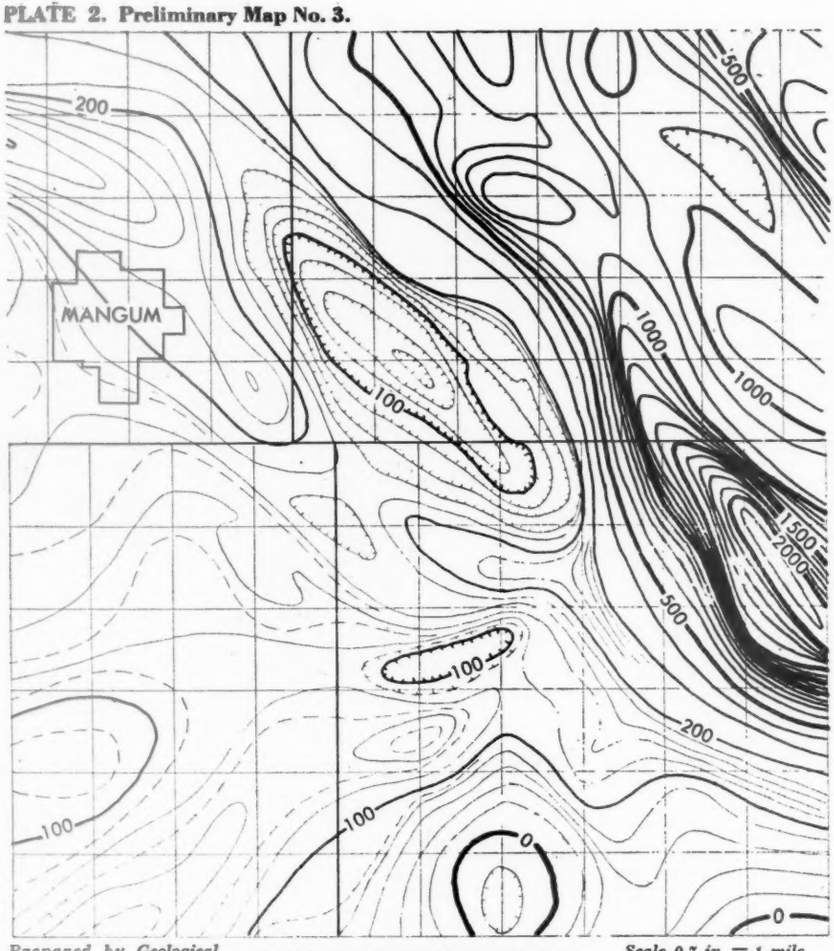
PLATE 2. Preliminary Map No. 3.



Prepared by Geological Survey, U. S. Department of Interior, from data collected jointly by the Geological Survey and Naval Ordnance laboratory for the Director of Naval Petroleum Reserves. December 1944.

TOTAL MAGNETIC INTENSITY
Mangum, Oklahoma
Flight level 1935 ft. above sea level.
ca 300 ft. above ground.

Scale 0.7 in. = 1 mile. Contour interval: to 300 gamma, 20 gamma with intermediate 10 gamma dashed; above 300 gamma, 100 gamma. Correction for regional variation, —7 gamma per mile to north and —2 gamma per mile to east.

vey geophysicists, the plane was used to make a very successful survey of 10,000 square miles of Naval Petroleum Reserve No. 4 in the northernmost part of Alaska. In order to obtain information to assist in the interpretation of the results of this work, the plane was also used to make a survey of the known oil-producing structures of the Big Horn Basin in Wyoming.

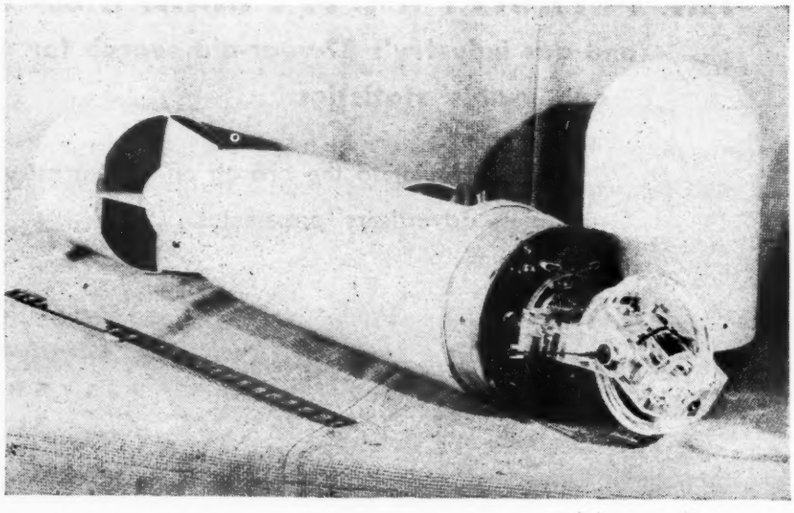
A highly useful system of equipment had by now been developed and proved to be practical, but to make it complete the geophysicists recognized that it must be modified to permit its use over water and unmapped areas where normal photographic methods of location are useless. The best means of doing this is by substituting Shoran, an accurate, short-range radio navigation aid, for determining exact position of the plane at all times. The Director, Naval Petroleum Reserves, arranged with the Air Technical Services Command to supply Shoran equipment and operating personnel for a survey off the coast of Texas and Louisiana. Naval Ordnance Laboratory incorporated the Shoran equipment into the PBY, and in March and April, 1946, Naval Petroleum Reserves, Air Technical Services Command, and U. S. Geological Survey personnel made a survey of about 9000 square miles of the coastal waters of the Gulf of Mexico.

Although further improvements will undoubtedly be made, the fundamental development is now complete. The Naval Ordnance Laboratory-Bell Telephone Laboratories airborne magnetometer is an accurate geophysical instrument that can be used to make extremely rapid reconnaissance magnetic surveys of any geologic environment at any useful altitude over any area that can be bounded on one side by a series of ground radar stations. Thus the joint efforts of many individuals and organizations have attained one of the major goals of geophysics: practical aerial magnetic surveys.

● **Instrument.** The airborne magnetometer now used for geophysical surveys consists of a modified AN/ASQ-3a magnetic airborne detector and a device for correlating the magnetic record with the plane's position in space.

Although the original antisubmarine device was equipped to measure accurately the total magnetic intensity, it was not generally used for this purpose. For that reason the sensitivity range was not sufficient and the rate of instrument drift was much too high to permit its use as a geophysical instrument. Requirements for a useful instrument were set up by the U. S. Geological Survey and the necessary modifications and improvements made by Naval Ordnance Laboratory and Bell Telephone Laboratories. Members of all three groups cooperated to develop the means for correlating the magnetic record with the plane's position in space. In all subsequent development this profitable cooperation has continued, with the actual improvements and modifications being made by Naval Ordnance Laboratory and Bell Telephone Laboratories according to the needs indicated by field surveys conducted by the U. S. Geological Survey. Most of the funds required for this work have been supplied by the Office of Naval Petroleum Reserves.

The AN/ASQ-3a is a fluxgate magnetometer that measures electronically the



Streamline body or "bird" with nose removed to show the intricate gimbal mechanism that orients magnetic detector in flight.

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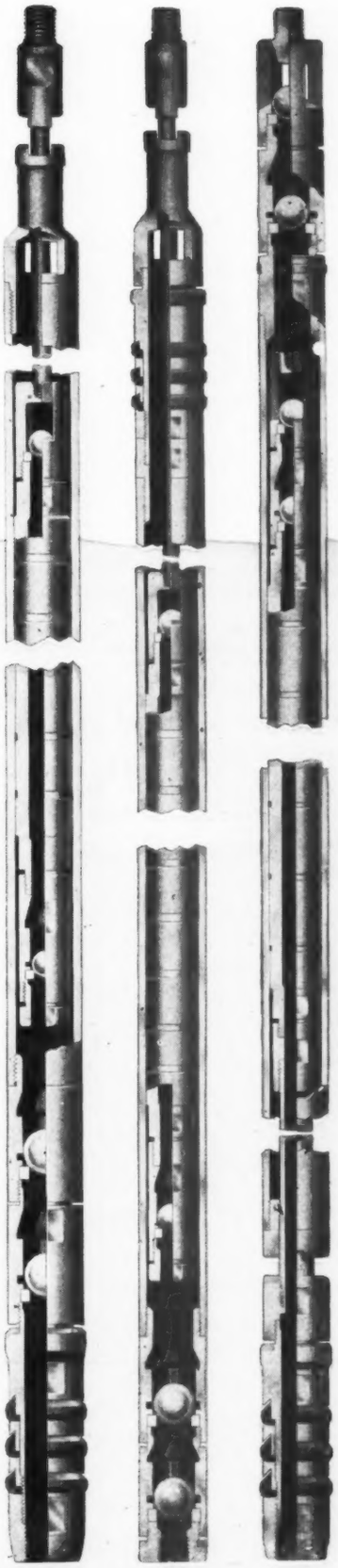

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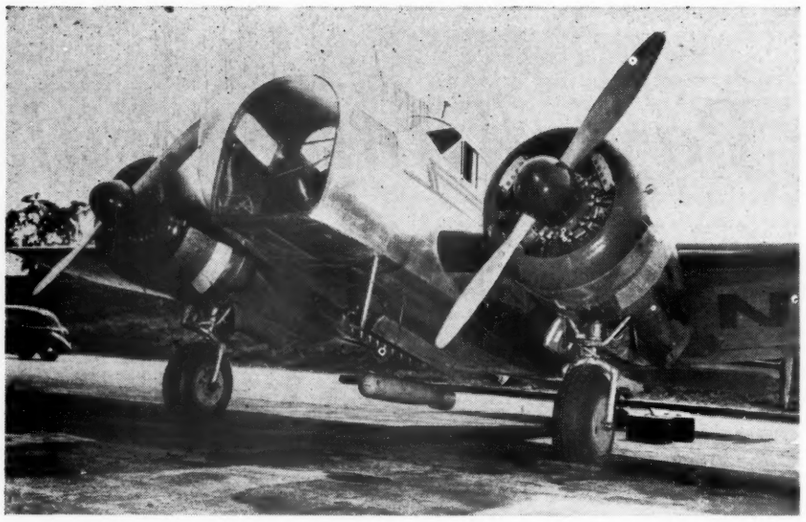
total magnetic intensity, and records it continually on a standard Esterline Angus record chart 4½ in. wide and about 80 ft. long. The E-A recording meter has a variety of speeds so that nearly any scales can be chosen for the chart, although it now appears that the most useful lie between one-half to two miles to the inch. The sensitivity of the modified magnetometer is instantly variable by means of a selector switch and can be set to give a full scale (50 divisions) deflection on the record chart equal to 50, 100, 200, 500, 1500, or 5000 gammas.[1] The value of the base line of the record chart is also instantly variable in 50, 500, or 5000 gamma steps by means of decade type controls. In the most recent installation the sensitivity and the value of the base line can be recorded on the record chart at appropriate intervals by an automatic stamping device, so that the total magnetic intensity can be instantly read at any point on the chart.

To eliminate the magnetic effect of the plane, the fluxgate mechanism, or detector element, is housed in a streamlined, bomb-shaped case, the "bird," which is towed behind and beneath the plane on a cable about 100 ft. long. In a large ship without magnetic materials in the tail section, such as the PBY, an inboard installation may be made in the tail. This eliminates the need for releasing and retrieving the bird, but there is usually some small effect of magnetic materials in the plane and the results are not quite so reliable as those obtained with a towed bird.

[1]One gamma equals 10^{-5} gauss. The earth's magnetic intensity varies from 25,000 to 70,000 gammas, depending upon latitude.



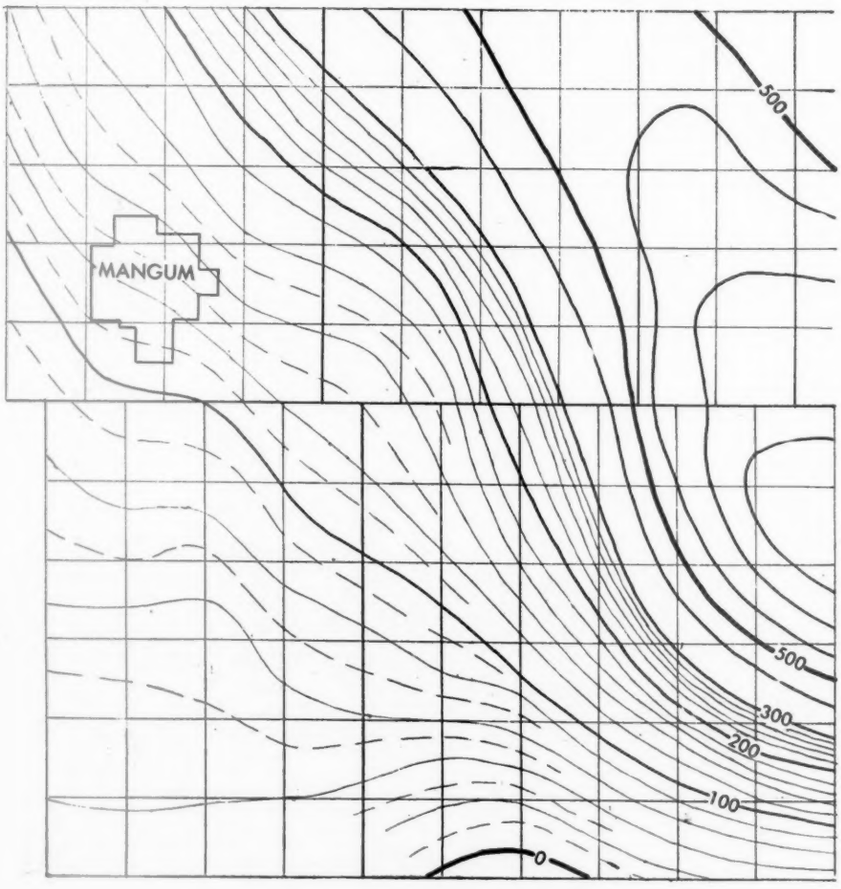
U. S. Geological Survey's twin engine Beechcraft, especially equipped with the NOL-BTL magnetometer and accessories by the Aero Service Corporation, is to be used for making magnetic surveys throughout the United States.

PLATE 2. Preliminary Map No. 3.

Prepared by Geological Survey, U. S. Department of Interior, from data collected jointly by the Geological Survey and Naval Ordnance laboratory for the Director of Naval Petroleum Reserves. December 1944.

TOTAL MAGNETIC INTENSITY
Mangum, Oklahoma
Flight level 7935 ft. above sea level.
ca 6300 ft. above ground.

Scale 0.7 in. = 1 mile. Contour interval: to 300 gamma, 20 gamma with intermediate 10 gamma dashed; above 300 gamma, 100 gamma. Correction for regional variation, —7 gamma per mile to north and —2 gamma per mile to east.



Several methods have been used to determine the position of the plane in space but experience has shown that for land surveys the method that will probably be most useful is that using a gyroscopically stabilized sonné continuous strip camera and a recording radio altimeter that measures height above ground. The three records are coordinated by an electrical system, which, by means of a hand-operated key, simultaneously makes edge marks on the total magnetic intensity chart and the height above ground chart, and photographs on the continuous ground strip an electric number counter that changes each time the key is depressed. This number is also recorded on the magnetic chart with the same automatic stamping device previously mentioned. By matching the continuous ground strip with high-altitude photographs on maps and knowing the height above ground, it is then possible to locate the traverse line and to plot the total magnetic intensity.

Another method for use over water or other unmapped areas involves the use of Shoran, a radio navigation aid. With this system the distance from two ground stations is measured electronically and is constantly recorded and coordinated with the total magnetic intensity chart. Knowing the position of the ground stations, it is then possible to locate the traverse lines without maps or other information, and to plot the magnetic intensity.

(The second and last installment of Mr. Balsley's article will appear soon.)

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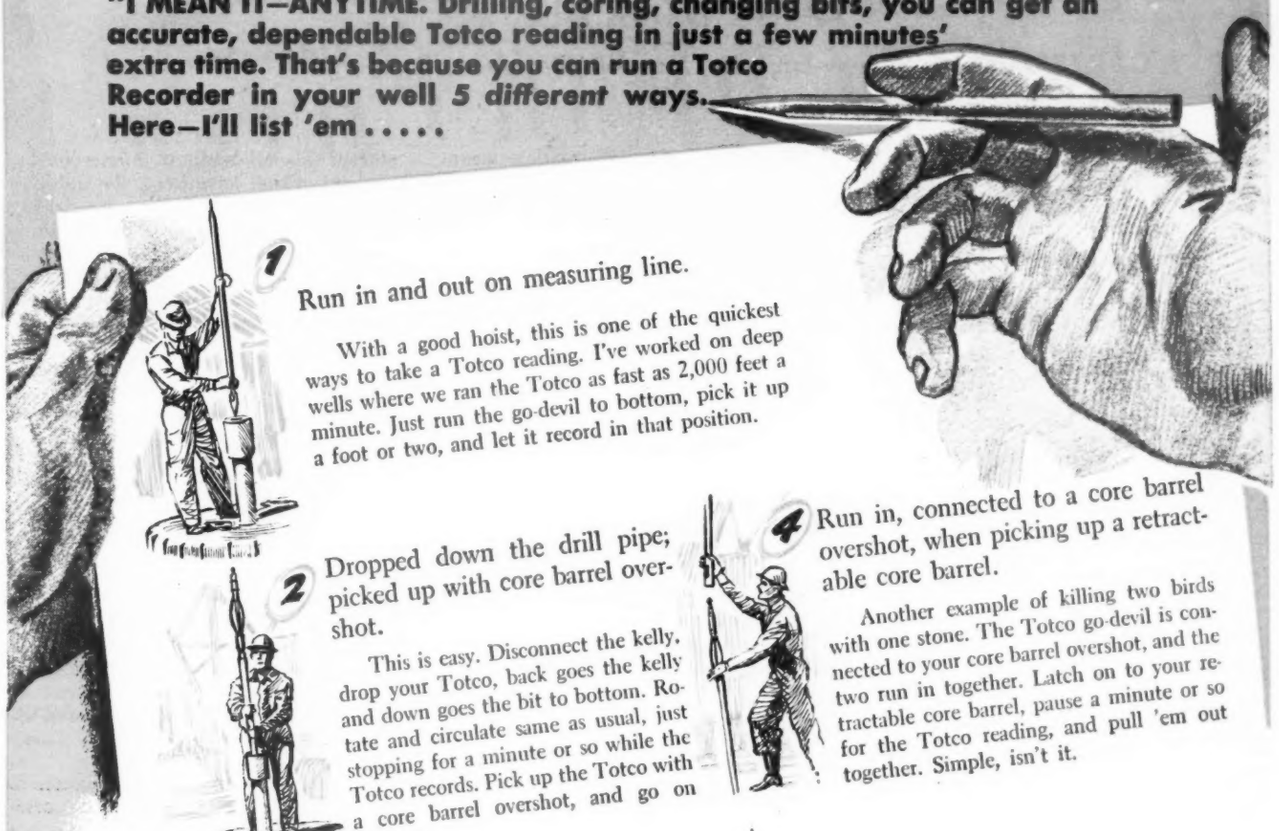

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3 Dropped down the drill pipe; recovered when bit is changed.

This is just the same as Method 2, except you drop the Totco just before you pull the string. After the Totco records, pull the string: you get the go-devil out of the drill collar when you break off the dulled bit.

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In this method, to keep the sand line from kinking and twisting, you use a go-devil assembly with sinker bars, and a swivel to let the line turn. This way, you get accurate readings, taken any time you want.

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The function and use of petroleum engineering committees

By **D. V. CARTER**, *Chief Petroleum Engineer*, Magnolia Petroleum Company

PART 1

● **Introduction.** I have been asked by your Chairman to discuss tonight the function and use of petroleum engineering committees, with particular emphasis on the Mississippi Oil and Gas Engineering Committee.

Within the past several decades those of us engaged in the exploration and operating phase of the oil and gas business have witnessed practically a complete change in what was commonly accepted as the proper operation of oil and gas reservoirs.

What has caused this change of operating concept? The explanation is simple . . . the application of technology[1] made possible largely by factual data. We have come to recognize the fundamental differences of several types of oil and gas reservoirs and the source of energy in each case.[2] Working in harmony with nature through an understanding of natural physical laws actually amounts to following "the line of least resistance."

We have finally come to realize that multiple surface ownership of common oil and gas reservoirs requires constructive and concerted operating action. As more and more operators become awakened to the fact that they are producing from common reservoirs, and that they can work together for their mutual benefit, petroleum engineering committees are being accepted. The organization of committees is generally undertaken by far-sighted individuals who recognize them as the logical means of providing a basis of common knowledge for cooperative effort at reasonable cost by avoiding repetition. It is as simple as this. It is a solution to the problem which is a fact that we cannot, at least as yet, "build fences" around the recoverable hydrocarbons and reservoir energy belonging to each leasehold.

In order for this to become a reality . . . the collection of adequate factual data is necessary. The mutual and appropriate application of this information means that we have made considerable progress toward an accepted common ground on which to base a study and discussion for meeting operating problems. For example, these operating problems may require for their solution unitization for effecting operating economies or for the purpose of supplementing reservoir energy by water, gas, or air injection. Or possibly a cooperative plan or an operators' meeting to discuss and consider changes in regulatory body field rules and regulations is all that is needed. Factual data are indispensable for all manner of reservoir studies and operating problems, not the least of which are reserve studies of a periodic nature or possibly valuation studies for purchase or sale of properties. Many of us have experienced the discovery that the solution of what appears to be a complex problem has a fairly simple explanation. Factual data are the principal constituents of an understanding.

It is surprising how factual data when collected and properly organized and presented will in themselves clarify some situations and make obvious some of those matters needing attention. Thus factual data may be likened unto mortar for the bonding of brick—if we consider the brick as the operators. What is the result? The gradual disappearance of the "chip on the shoulder" type of operator often closely allied and confused with the so-called "rugged individualist."

Within certain recognized limits experienced engineers using the same set of basic factual data are not only more likely to be in agreement regarding a given problem but will probably also recognize inherent trends and possibly the need for further investigation. Factual data provide a basis for and foster voluntary discussion of many operating problems, possibly of less calibre than unitization or a cooperative plan for reservoir operation.

The meaning of factual data is simple. It includes all factors relating to changes as the result of fluid withdrawal from the reservoir, analyses of reservoir fluids, necessary factual geology, and statistics with reference to wells drilled and abandoned. Factual data constitute the primary objective of fact-finding petroleum engineering committees,, whether they be on a field, area, or statewide basis.

● **Historical review.** I would like to make the observation that from away back yonder—in fact, even as early as only 13 years after Drake officially started this oil business, numerous and cyclical crises[3] have beset the industry. These crises in the drilling, producing, purchase, and transportation phases of the industry are liberally sprinkled with economic troubles of a "feast or famine" nature. This is particularly true with reference to the availability and price of crude oil.[4]

Rampant monopolistic accusations and the titanic struggle for survival and maneuvering for position on the part of producing and other elements characterized the industry in the period 1859 to the early 1900's. During this interval, the industry was endeavoring to emerge from the formative stage and attain further growth with some degree of maturity. Even in the seventies, a search of the literature reveals[5] that producers in the Clarion and Butler fields, Pennsylvania, were discussing among themselves plans for combatting the economic peaks which were the direct result of rate of field discoveries, market demand, and the machinations of the purchaser, transporter and refiner.

Similar situations of overproduction, market demand, price, and transportation difficulties continued to plague the industry, e.g. Illinois[6] 1906-1910, Cushing[7] 1912, Healdton[8] 1914, the fields of the Greater Seminole Area[9, 10] 1927, and Oklahoma City,[11] Oklahoma 1931.

Meanwhile, let us see what the effect and the relationship of these events were with respect to cooperative fact-producing petroleum engineering committees:

The Greater Seminole Area, Oklahoma, development starting in 1926 was the first instance of operators voluntarily employing an umpire[12] to effectuate a

*Delivered before a joint meeting of the Illinois Society of Petroleum Engineers and the Illinois Basin Chapter of the American Petroleum Institute, Mt. Vernon, Illinois, March 1, 1946.

1. "The Development of Some of Our Concepts of Fundamentals Governing Petroleum Production Practice." E. DeGolyer. API Spring Meeting, Southwestern District, Division of Production, Houston, Texas. (March 28, 1940). (Unpublished paper.)
2. "Report of the Engineering Committee of the Interstate Oil Compact Commission." E. DeGolyer, Chairman. Submitted at New Orleans, (April 14, 1941).
3. E. DeGolyer, personal notes.
4. E. DeGolyer, personal notes.
5. E. DeGolyer, personal notes.
6. "The Oil Fields of Crawford and Lawrence Counties." Raymond S. Blatchley. *Illinois State Geological Survey Bulletin* No. 22. 167-168 (1913).
7. E. DeGolyer, personal notes.
8. E. DeGolyer personal notes.
9. E. DeGolyer, personal notes.
10. E. DeGolyer, notes on John Lovejoys' comments on "The Trend of the Petroleum Situation." J. E. Pogue. *AIME Petroleum Development and Technology.* 717 (1927).
11. "Proration at Oklahoma City, Oklahoma." Harold F. Thomas. *Bull. Amer. Assoc. Petrol. Geol. 16* (10) 1021-1028, October (1932).
12. E. DeGolyer, personal notes. Since writing this paper the author's attention was called to the fact that the Salt Creek Oil Field in Natrona County, Wyoming, was curtailed during part of 1921, all during 1922, and part of 1923, according to Fig. 12, p. 26 (Proceedings, Second Midyear Meeting, Division of Production, A.P.I. Bulletin No. 209, at Tulsa, June 1-3, 1932). According to a personal communication from Paul D. Torrey of Houston, Texas, J. J. Zorichek, Chairman of Rangely Engineering Committee, stated that M. J. Foley, now of Denver, Colorado, was employed as Umpire by the Salt Creek operators during that period.

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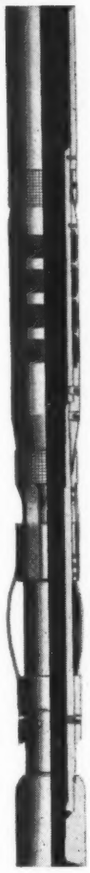

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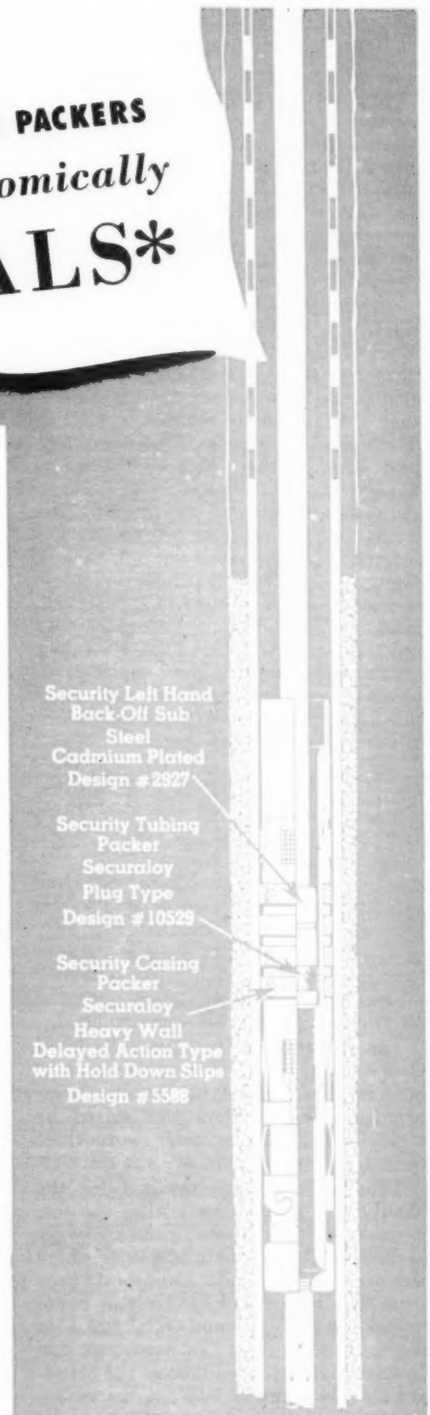
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degree of ratable take among the producing factions. These few attempts on the part of the operators to approach some degree of production allocation were relatively mild and of comparatively short duration. This action was premised on the proposition of overproduction with respect to market demand and outlet, and with a dash of hope that some conservation benefit would be derived together with a somewhat lessened need for above-ground storage.

Again, a similar situation of overproduction occurred in the Yates field,[13] West Texas. This field, discovered in 1926, had developed a potential production of such magnitude two years later that it demanded an immediate solution. The operators organized a committee[14] and some of the operators signed an agreement effective October 1, 1927, for the primary purpose of allocating the production of oil between the various leaseholds in this field. The functions of this committee have expanded to include the gathering of factual data and it has become a full fledged petroleum engineering committee. This Yates Pool Committee,[15] as finally evolved in 1928, developed into the first field cooperative petroleum engineering committee in Texas and the United States.

These troubled conditions appeared from time to time until the early thirties. Then, the discovery of the East Texas field pulled the cork on the available oil and brought the matter of conservation up sharply as a problem to be solved by the industry and several of the state regulatory bodies. Actually, the overproduction problem, at this time, was of such import that it rightfully concerned all legislatures and regulatory bodies of oil producing states, but some reneged.

The industry and the Texas Railroad Commission, the oil and gas regulatory body of Texas, bore the brunt of this problem. The problem was solved by several of the state regulatory authorities with the aid of numerous court tests.

Thus a betterment resulted for the handling of such matters after the formidable problem caused by the discovery of the East Texas field in late 1930, which was preceded by similar important crises from the discovery of the Greater Seminole Area, the Yates and Oklahoma City fields. Backing up a few years, we can now see that the dissolution of the Standard Oil Company in 1911, to the disappointment of some, did not affect for the better or diminish, necessarily, these recurring economic spasms.

The Yates Committee was followed in 1933 by the organization of the Conroe Field Engineering Committee,[16] a subcommittee of the Association of Conroe Operators Land and Royalty Owners. In the same year, the East Texas Engineering Association was formed.

The first area engineering committee organized was the Lea County Engineering Committee, an outgrowth of the Hobbs Operators Agreement,[17, 18] dated July 10, 1930. The second area committee was the North Basin Pools Engineering Committee,[19] organized in March, 1939. The North Basin Committee includes many of the larger pools of the West Texas Permian Basin.

The oil industry in the state of California has a rather unique situation. It is the only major oil-producing state without proration laws. A voluntary restriction of oil and gas withdrawal rates is engaged in under a state "Conservation" program. The statewide organization known as the "Conservation Committee of California Oil Producers"[20] together with its predecessor organizations has been performing continuously since the fall of 1929. This is the first statewide cooperative engineering committee in the United States.

The reoccurrence of development activity in Arkansas in early 1937 witnessed the formation of a statewide cooperative engineering plan. The operators organized the "Arkansas Operators Committee,"[21] which was administered by the State Board of Conservation. This was the second statewide-cooperative committee. The committee recommended well spacing, drilling, and production policies. The committee functioned until the passage of appropriate state legislation on February 20, 1939,[22] which created the present Arkansas Oil and Gas Commission effective April 1, 1939.

The third statewide engineering committee is the Mississippi Oil and Gas Engineering Committee, organized January 12, 1945. This Mississippi Committee is the first statewide organization whose sole purpose is the collection and dissemination of factual data.

A better understanding of the mechanics of oil and gas reservoirs through the gradual application of technology, legislative help, and clarifying aid from the Courts, paved the way to a better realization of the general problem of conservation. The term conservation is here used in the broadest sense. State regulatory bodies took further steps to regulate on the grounds of conservation after their authority had been sufficiently measured, although it was crystallized to a greater extent by 1939.

To illustrate how far we have come in 20 years: Many of you can remember before the advent of applied technology that when someone desired data other than ordinary production statistics for all or part of a field, he was looked upon by many well-meaning people in authority as one "too big for his britches" and was mentally catalogued by them as being "nosey." This attitude was due, obviously, to a lack of understanding of the application of technology. Another classic example of lack of understanding is the fact that it was not the custom to tube flowing oil wells before completion. It was literally a major victory to obtain permission to "run tubing" in a well before completing. Then the East Texas field was discovered and the use of tubing in wells was made mandatory. This practice spread throughout Texas and several other states. It is now accepted without question, and so it goes.

What is the connection between all this and fact-producing petroleum engineering committees? Simply this—technology and its application to the oil and gas business requires technical data. As this type of committee offers the most practical and logical way to obtain the desired data, their initiation was inevitable. The need for engineering committees was accelerated by the occurrence of problems of such magnitude as to be too difficult and inherently impossible of solution on the part of individuals, companies or groups within the industry. In addition, a remedy sought must fulfill the necessary legal, technical and economic requirements. Thus, after much groping we have an instrumentality and a better understanding among ourselves to permit us not only to better attack problems, but also to improve our concept of what constitutes good operation. So you see, the birth of such committees for the production of technical facts could not be avoided. They have come to be indispensable. They are here to stay.

To show the importance and extent to which this type of committee has grown: I estimate that at the beginning of 1945 for the states in which they operate, except Colorado, namely Texas, California, Oklahoma, Louisiana, New Mexico, and Mississippi, 48 per cent of the crude oil and condensate reserves in these states shows evidence of the application of scientific producing methods. It is also of interest that I estimate 43 per cent of oil and condensate reserves of the United States shows effects of petroleum engineering.

Later on, the scope of activities of these committees will be discussed; how they differ and what legal domains they occupy.

● **Organization, scope, and legal aspects.** At this juncture it may be well to define a petroleum engineering committee. Generally speaking, it is an organization composed of technical representatives of operators working together for the purpose of gathering, pooling, and distributing factual data to provide a common basis for the understanding of mutual problems. In actual cases, various committees are modified to some ex-

13. "Petrolcum Engineering Report, Biz Spring Field and Other Fields in West Texas and Southeastern New Mexico." Charles B. Carpenter and H. B. Hill. *U. S. Bureau of Mines Report of Investigation No. 3316.* 96-118 (November, 1936).
14. H. B. Fuqua, Gulf Oil Corporation, personal communication.
15. "Oil Field Operation with Cooperative Engineering Committees." V. E. Cottingham. *Interstate Oil Compact Quarterly Bulletin.* 2 (4) 15, December (1943).
16. Alexander E. Deussen, Chairman, Association of Conroe Land and Royalty Owners, communication.
17. "Oil and Gas Development in New Mexico." A. Andreas. *The University of New Mexico Bulletin* Whole No. 343, Geological Series, 5 (3) 15, May (1939). Paper presented at New Mexico Oil Conference, May 5 and 6, 1939.
18. "Oil Field Operation With Cooperative Engineering Committees." V. E. Cottingham. *Interstate Oil Compact Quarterly Bulletin.* 2 (4) 19, December (1943).
19. Ibid. pp. 20-25.
20. William R. Wardner, Jr., Administrator, Conservation Committee of California Oil Producers, communication.
21. "Practical Application of Planned Optimum Rate Proration." Alec M. Crowell, *The Petroleum Engineer.* Part I, *12* (3) 37, December (1940). Part II, *12* (4) 54, January (1941).
22. *Arkansas Natural Resources—Their Conservation and Use.* Appendix "A." (Conservation Laws.) Compiled by Robert A. Leflar. 402. Little Rock. (1942).

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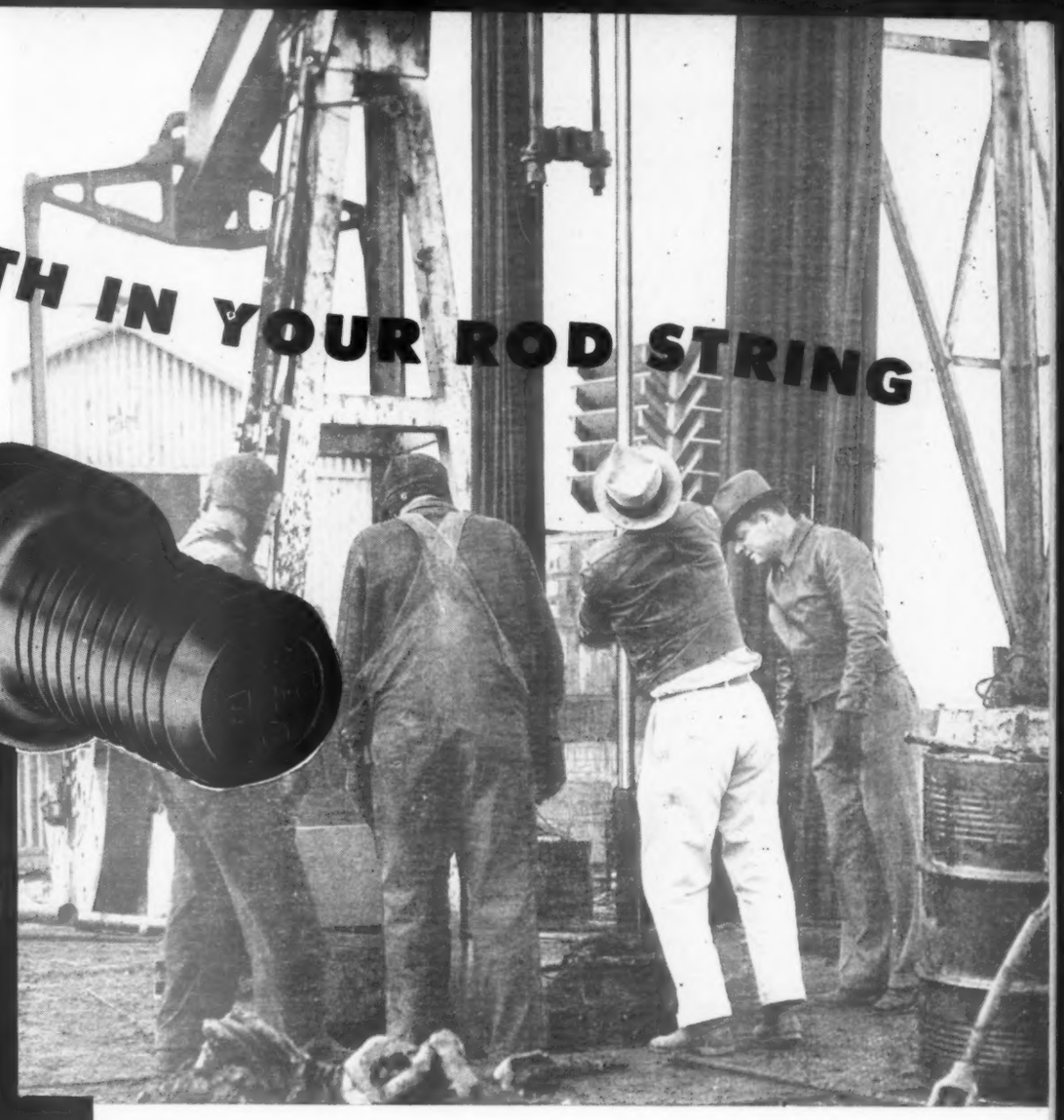

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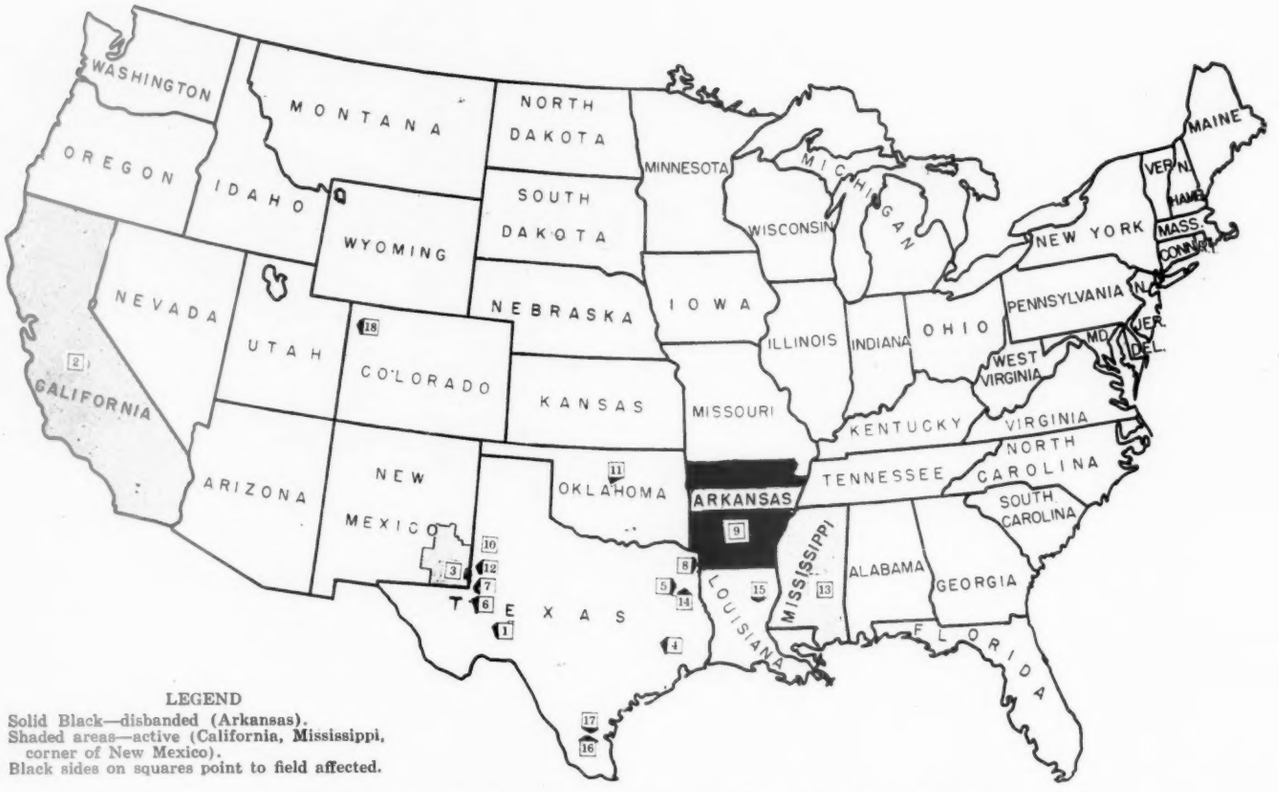

LEGEND
Solid Black—disbanded (Arkansas).
Shaded areas—active (California, Mississippi, corner of New Mexico).
Black sides on squares point to field affected.

Distribution of petroleum engineering committees in the United States.

1. Yates Pool Engineering Committee—1928
2. Conservation Committee of California Oil Producers—1929.
3. Lea County Engineering Committee—July 10, 1930
4. Conroe Field Engineering Committee—March 11, 1933
5. East Texas Engineering Association—August 4, 1933
6. Judkins Pool Engineering Committee—1934
7. Goldsmith Pool Engineering Committee—January 25, 1937
8. Rodessa Engineering Committee—January, 1937 (Discontinued—January, 1944)
9. Arkansas Operators Committee—November, 1937 (Discontinued—February, 1939)
10. North Basin Pools Engineering Committee—March 1, 1939
11. West Edmond Engineering Association—May 16, 1944
12. Fullerton Engineering Committee—November 15, 1944
13. Mississippi Oil & Gas Engineering Committee—January 12, 1945
14. Carthage Field Engineering Committee—March 7, 1945
15. Holly Ridge Engineering Committee—March 16, 1945
16. La Gloria Engineering—July 19, 1945
17. Seeligson Engineering Committee
18. Rangely Engineering Committee

tent, but all adhere to the one basic purpose of obtaining factual data.

Most of the petroleum engineering committees subscribe to the simple basic structural form exemplified by the Mississippi Oil and Gas Engineering Committee, which also sets a pattern for future statewide committees. The organization consists of three essential parts: (1) A general committee, (2) an executive committee and (3) a full-time paid director and his staff. The general committee is composed of one technical representative from each participating operator, such representative being either a technically trained man or engaged in a supervisory capacity in petroleum production. A general committee chairman, a vice chairman and a secretary-treasurer are elected from the membership to serve for a term of one year. I had the honor of being elected general chairman for the first year.

The executive committee consists of seven members elected from the general committee with the stipulation that all should, if possible, be residents of the State of Mississippi, and at least five of the members be representatives of oil or gas producers in the State. The executive committee elects its own chairman and secretary.

The full-time, paid director is chosen by the general committee. The staff is selected and matters of policy are acted upon by the director, the executive committee and general officers.

The general engineering committee passes on all matters of broad interest brought before it. It should be emphasized here that each participating operator is allowed only one vote in committee affairs, regardless of the magnitude of his operations in the State. The executive committee assists the director in the activities of the organization and passes on all expenditures over $500.00 The staff, under supervision of the director, maintains records of factual data for all fields.

Committee equipment and personnel are used, if necessary, to run reservoir pressure tests, gas measurements, echometer tests, salt water gauging, and other tests. When the occasion arises, a special field engineering committee for a particular field can be appointed by the director with approval of the executive committee.

The Mississippi Committee publishes a quarterly report of factual data in which is presented up to date development maps and all available information for each field, including graphic reservoir histories. The material is complete enough to permit the evaluation of reserves and to make other important studies.

Between factual data reports, a monthly Interim Statistical Bulletin is published supplying up to date production data and all available information on new wells and developments. In other words, these two reports comprise a valuable current and cumulative engineering survey of each field.

I would like to emphasize here that neither the director nor any member is allowed to speak for the committee, although each may make his own personal comments. Hence, no recommendations are made by the director or his staff; interpretation of the data is left to the operator. The circulation and use of the data is restricted to the committee membership and to the supervisor of the State Oil and Gas Board of Mississippi, who is an ex-officio member of the committee. Private enterprise is thus doing that which would sooner or later be done

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The cost of membership is small. There is an annual fee of $100 for each member plus an additional monthly assessment to members having oil and gas production in the state. The assessment is made on a per barrel basis determined by each member's percentage of the total state production for all participating members. This monthly assessment has now been reduced to approximately 2 mills per bbl. The articles of this committee also provide with reference to the assessment of gas: "The inclusion of gas production in the expense of this organization is to be made on an equalized value basis to be formulated by the executive committee when gas production is secured from new pools."

A copy of the Articles of Organization of the Missisippi Oil and Gas Engineering Committee appears in the Appendix.

As now constituted the functions of the "Conservation Committee of California Oil Producers" [23, 24, 25] is primarily to determine the maximum efficient rates of production (M.E.R.) for the various pools based upon reservoir engineering studies and evaluation of their performance record. Another function is to make recommendations to the operators for the distribution of production to individual wells in accordance with best engineering practice considering property equities..

The Conservation Committee distributes monthly schedules to the individual operators for each flush and semi-flush pool as well as statements of production on a well by well basis. Summaries of monthly pool total and company field production are published on a statewide basis and made generally available. The committee's paid staff secure from the companies complete records on a well, lease, and pool basis for production of oil, water and gas. These data include copies of the regular monthly production report filed with the California State Mining Bureau, Division of Oil and Gas. These records are augmented by reports from purchasers for oil shipped and producers' reports on storage and lease use of crude. Well completion reports covering coring records, perforations, zone encountered and other data are also submitted.

The Committee has a paid manager and his staff. The work is reported to two subcommittees: The administrative and the engineering subcommittees. The state is divided into 27 districts, each with a district committee and a field engineering committee. Whenever it is decided to investigate a field problem either through desire of the committee or by petition of an operator, two special study committees are appointed: (1) The pool engineering committee and (2) the pool operators committee. The pool engineering committee consists of qualified operators' representatives directly interested in the problem who collect the necessary data and prepare a report including recommendations. The report is sent to the pool operators committee, the conservation engineering subcommittee and to the manager, all under confidential seal. The manager places it before the proper subcommittee for action. The members of all committees, except for the manager and his staff, are employe representatives of the operators.

The acceptance of this program in California has been largely attributed to "self-selling." There is a growing realization on the part of the operators themselves that they will ultimately benefit both from higher oil recoveries and reduced operating costs. This consciousness is largely a result of education and enhanced knowledge relative to the conditions in the oil pool under study. Knowledge of their problem is to a large measure acquired out of the coordinated work of their field engineering committees. The factual data developed are the basis of sound engineering judgment and joint operator action in support thereof. The active participation by the company engineers in jointly studying reservoir behavior on a pool basis and making recommendations for improved production practice has in a large measure been responsible for the high degree of compliance with the voluntary program in California.

It is certainly commendable to the operators in the State of California that they have been able to maintain a reasonably effective control of such a difficult problem as "proration" on a voluntary basis. To me it shows that knowledge and understanding of a common problem and a neighbor's position tend to dispel distrust and promote cooperation.

Under California law for the conservation of petroleum and gas the state maintains an oil and gas supervisor. He directs the work of the Division of Oil and Gas of the State Mining Bureau.[26] There are six districts with a deputy in charge of each. The primary work of this department is to control well completion practices, particularly to exclude water from petroleum reservoirs, as well as to prevent oil or gas contamination of water supplies. Venting of gas to the air is prohibited, and this provision is closely adhered to. Stress is made to avoid any surface waste, and, in general, California companies utilize within practical operating limits the entire production of gas from oil wells. This, in part, is due to a condition of low gas reserves and high demand on the Pacific Coast.

The Division of Oil and Gas functions also include but are not limited to the following:

1. Maintenance of records of well and property ownership.

2. Maintenance of records of notices of intention to drill new wells and redrill old wells.

3. Supervision of well abandonment.

4. Procuring and maintenance of monthly statements of production of oil, gas and water by wells and property totals.

An example of an efficient area engineering committee is the North Basin Pools Engineering Committee[27] under the chairmanship of V. E. Cottingham. This committee, established on March 1, 1939, has under its jurisdiction 10 fields in the north end of the Permian Basin area, including such large fields as Slaughter, Seminole, and Wasson. The structure of the committee compares favorably with that of the Mississippi Committee, having the same essential sections, that is, a general engineering committee, an advisory subcommittee and a full-time, paid chairman and his staff. In addition, an operators' committee is also included whose members are not necessarily technical men.

The staff, under supervision of the chairman, conducts reservoir pressure tests with committee equipment, assembles gas-oil ratio data and witnesses potential tests of wells. The North Basin Committee differs markedly from the Mississippi Committee in that operating recommendations in keeping with sound conservation practice are made by the chairman. By contrast, as previously mentioned, the Mississippi Committee director cannot make any recommendations in an official capacity.

An annual report and monthly statistical bulletin are distributed by the North Basin Committee, containing production data, potential tests, reservoir pressure and gas-oil ratio surveys. These bulletins, of course, are restricted to the committee membership.

There are many individual field engineering committees of which a typical example is the Goldsmith Pool Engineering Committee of West Texas. The Goldsmith field was discovered in 1934 and a formal engineering committee was established by the operators several years later on January 25, 1937. Here again the same fundamental organizational pattern is employed as is found in the Mississippi and the North Basin committees: a general engineering committee, an executive committee and a full-time, paid chief engineer and his staff. The duties of the chief engineer and staff of the Goldsmith Committee are very similar to those of the North Basin Committee. Under supervision of the chief engineer, the staff conducts reservoir pressure tests and witnesses gas-oil ratio surveys and potential tests. The chief engineer also recommends prudent operating practice based on a sound conservation policy. A monthly statistical report containing the results of gas-oil ratio and reservoir pressure surveys and production data is distributed to the member operators in the field.

23. Clark Gester, Standard Oil of California. personal communication.

24. Warner Clark, Standard Oil of California, personal communication.

25. Walter R. Wardner, Jr., Administrator, Conservation Committee of California Oil Producers, personal communication.

26. William R. Wardner, Jr., Administrator, Conservation Committee of California Oil Producers, personal communication.

27. V. E. Cottingham, Op. cit. pp. 20-25.

(This is the first part of an article by Mr. Carter. The second part will appear in an early issue.)

★ ★ ★

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Other equipment and methods used in the physics division include X-ray diffraction and electron diffraction, surface area measuring equipment, and a wide variety of physical and electrical apparatus for determining various properties of oils and catalysts, such as dielectric constants, porosities, freezing points, etc.

Infrared rays are those that warm us when they are radiated from a stove, an electric heater, or other hot surface. Ultraviolet or actinic rays are those superardent radiations that blister the human skin when it is imprudently exposed to the sun.

Oils and catalysts indentified and analyzed by physical and electrical apparatus in refining research.

Costly and delicate apparatus has been developed for this type of research, the purpose of which is to discover facts that are directly applicable to the immediate or future improvement of refining operations and which ultimately redound to the benefit of every user of gasoline and all refined products, including rubber, detergents, and other derivatives producible commercially from crude oil.

Large recording infrared spectograph.

These modern techniques do not supersede nor invalidate the time-honored distillation, viscosity, gravity, pour test, and other physical and chemical tests that for so long have been standard in the refining industry, but their range of usefulness goes far beyond that of the older methods.

The invisible light rays reveal important characteristics of individual hydrocarbons that cannot be discovered by any other method; furthermore, they permit many of the standard determinations to be made in a fraction of the time required by former procedures and with greater accuracy; for example, analyses of toluene, xylene, butadiene, and alkylate.

Explaining in a few words the function of the invisible rays, a physicist says:

"A refiner's gasoline may look water white, but to the ultraviolet and infrared 'eyes' of the physics department instruments, it exhibits a myriad of 'colors' unseen by the human eye, which serve to characterize it more rapidly and more thoroughly than the older methods."

The same principle governs both infrared and ultraviolet procedures and the apparatus in both cases is similar. It consists of a source of radiation such as a mercury arc lamp or incandescent body, a prism (quartz or rock salt) to classify the rays according to wave length (color), and a detector. The rays pass through the hydrocarbon sample to the detector, which measures the quantity of radiation not absorbed by the sample. The variation of this value at different wave lengths, or colors, discloses to the technologist the identity of the material being tested.

The results of the information so procured, along with the results obtained from data derived by other scientific methods in the various departments of the UOP laboratories, are used to help solve the problems of licensee refiners. Thus is put into their hands more complete information than they ever had before. This enables them to evaluate and realize the potential values of the crude they run and to improve their present operations. It also points the way to the possibility of making new and more valuable products from petroleum in the future.

Another major function of the physics division is the study of catalysts. As every refiner knows, catalysis was the

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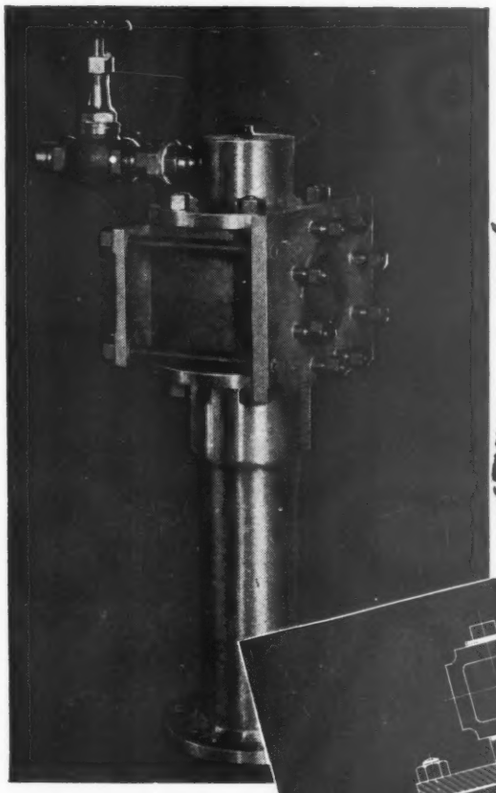

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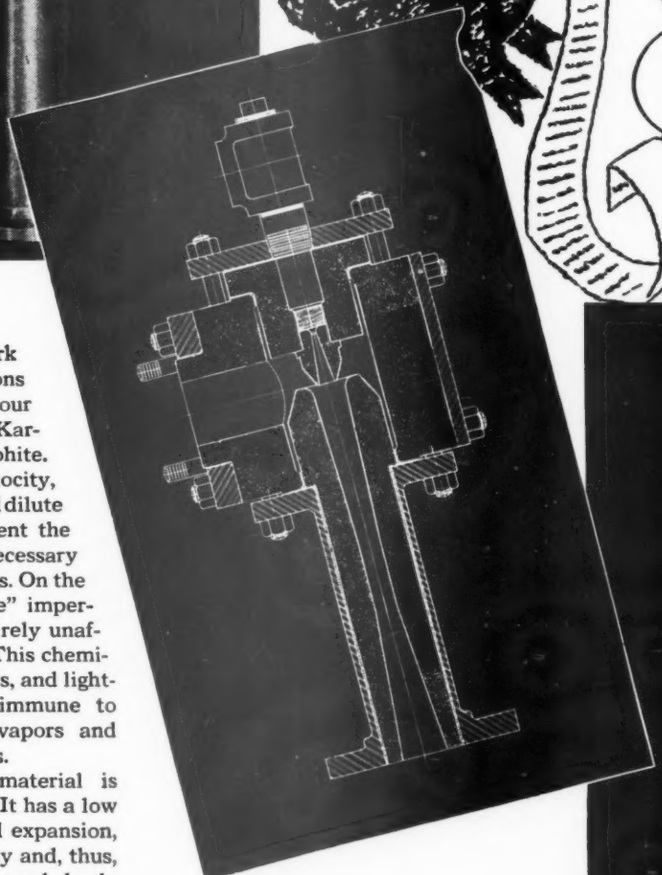

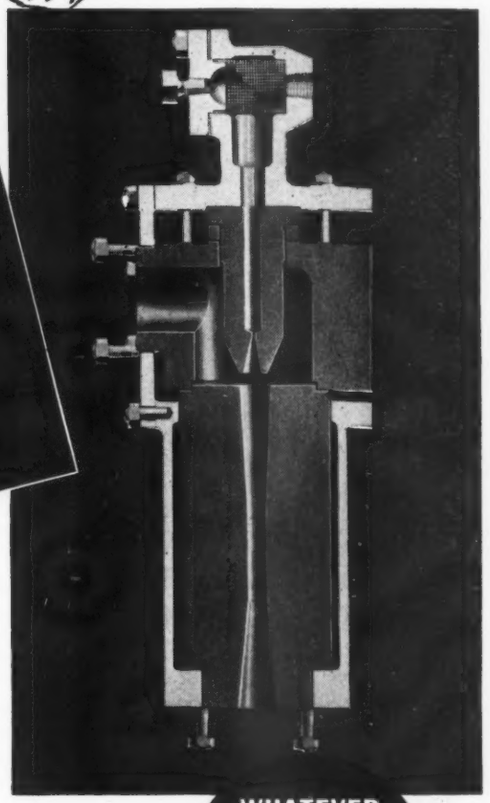

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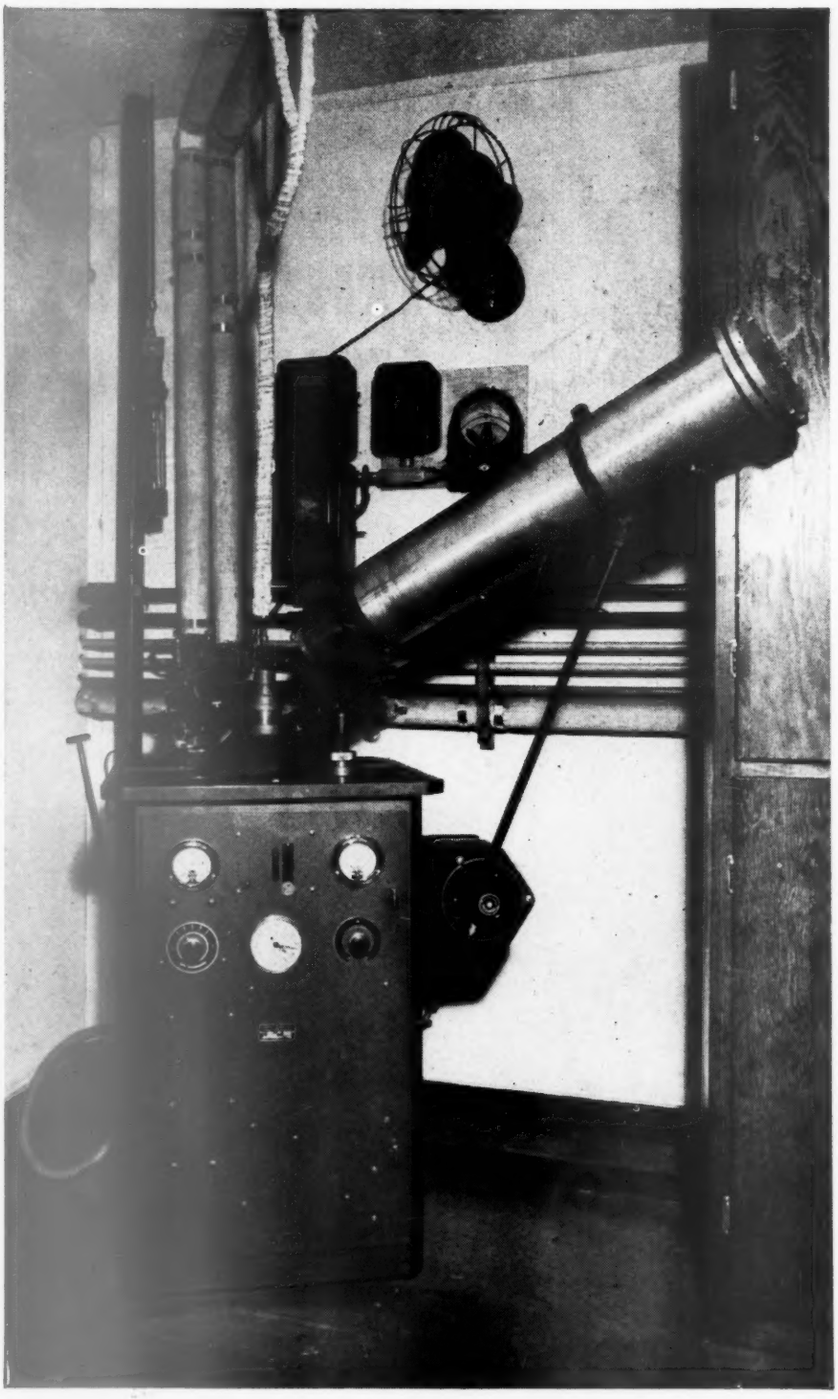

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key to our victory in the air in World War II, and it is a factor of growing importance in peacetime industry.

The millions of barrels of aviation gasoline (100 octane and better) produced for our fighting flyers was almost entirely custom built by use of a group of catalytic processes with catalytic cracking playing the leading role and catalytic polymerization, alkylation, isomerization, hydrogenation, and dehydrogenation having important parts.

Large quantities of synthetic toluene and other aromatics were made from petroleum by catalytic methods. The chief components of Buna S rubber, namely, styrene and butadiene, are produced by catalytic techniques.

In applying catalysis to practical peacetime uses, the character and fundamental behavior of various catalysts are of vital interest to refiners. The important characteristics that determine the performance and life of a catalyst include chemical composition, method of preparation, density, porosity, surface area, crystalline structure and particle size.

Innermost secrets in the makeup of catalytic materials are laid bare by X-ray and electron diffraction techniques. The X-ray equipment consists essentially of a source of radiation (X-ray tube), a "slit system," which is a tube perforated by slits or pinholes to define the beam, and a photographic film, arranged as a cylinder with the sample under test in the center. The X-ray is popularly known for its ability to pass through solid bodies; however, in catalyst testing, it is the radiation that is deflected by the sample that tells the story.

The X-rays are projected through the slit system onto the sample. Some of the radiation is absorbed by the sample—a portion is deflected by it. The deflected rays strike the film at various positions where they are recorded. After the test, the distances between the positions are measured. These distances indicate the arrangement of atoms in the sample, the atomic arrangement in turn betraying the identity of the material just as a thumb print identifies a felon.

Another powerful tool for investigating fundamentally important properties of a catalyst is the electron microscope. The standard form of electron microscope takes shadow pictures, magnified as much at 150,000 times. Pictures are taken by this instrument of individual large molecules that cannot be photographed by any other known method.

The electron microscope in the physics division has been modified to permit the study of crystalline structure of catalysts by electron diffraction. The construction of the electron microscope is analogous to that of the ordinary optical microscope, but whereas the optical instrument operates in the air on a beam of daylight or artificial light, the electron microscope operates in a vacuum on a beam of electrons derived from a heated tungsten filament. The electron beam is focused by means of magnetic coils that are analogous to the glass lenses of the optical microscope.

Information developed by the X-ray and electron microscope techniques was a major contribution to the development of the catalysts used in the scores of large scale catalytic units that made up the wartime 100-octane gasoline facilities, and was partly responsible for keeping production of gasoline at the highest possible level.

The novel improvements in the catalyst used in the UOP modified fluid catalytic cracking unit were developed in part from data derived in the physics department.

More than one refiner is enjoying more profitable operations today because of techniques and facts discovered in the physics division and other departments of the UOP laboratories.

The work of this division has been increasing in scope and importance for several years. To permit continued expansion, a functional building that will house the apparatus, laboratory and personnel of the physics division is nearing completion. ★★★

Computing values from orifice meter charts

By **W. F. MARTIN,** Texoma Natural Gas Company

THIS article does not undertake to deal with the merits or demerits of computing values from orfice meter charts by planimeters. It deals particularly with the factors used in connection with this type of computation.

EXCLUSIVE

The writer has recently had some experience with square root planimeters and the prepared tables of factors supplied with them, these tables being based on a chart period of 24 hr.

Many 48-hr. charts are now in use, and although it is possible to use a 24-hr. table in connection with them, there is a possibility of confusion where a worker handles many charts. It is of course possible to prepare tables for any unit of time desired, but in the writer's opinion the use of tables requires too much time when the cry is for speed and more speed. Cutting minutes off of hours has meant progress for us as a people, and has kept us ahead of the parade.

The use of a table requires a mental calculation on the part of the chart worker, a subtraction of "time off" from "time on" when the chart does not remain on the meter gauge a full period, or a subtraction of "time on" from "time off" when it remains on longer than a full period. The subtraction must be made to arrive at total time on, for which a factor must be found.

It has been customary to figure time to the nearest 15 min., but there is no real reason for this except for the preparation of tables, when tables were a real necessity. As tables have a tendency to impede the progress of work insofar as chart computation is concerned, it is the writer's opinion that such tables should be discarded for a simpler, faster, and more efficient method.

A simpler method would be to abolish all mental calculation on the part of the chart worker. A faster method would be to have worker place one indicator on "time on" and another on "time off," and at the "time off" indicator read the desired factor (a divisor instead of a multiplier in this particular case). A more efficient method would be one not limited to any particular period of time, running the time from "time on" to "time off." We are always striving for greater accuracy, and this would be a step in the right direction. Why read a chart to the nearest 15 min. when it is possible to read it to the nearest minute, and with less effort?

The writer has developed an idea on factor-finding that he wishes to pass on to others who may be interested. It is a device consisting of:

1. A lower disk with time divisions. (An ordinary orifice meter chart will suffice, and is used in this instance.)
2. An upper disk consisting of a percentage scale. This scale has ten major divisions, 100 intermediate divisions, and 1000 minor divisions. It will permit direct reading to three places, and an estimate of the fourth.
3. An arm pivoted in the center of the disks, on which is drawn a fine center line. (The finer the line, the closer the reading can be.)

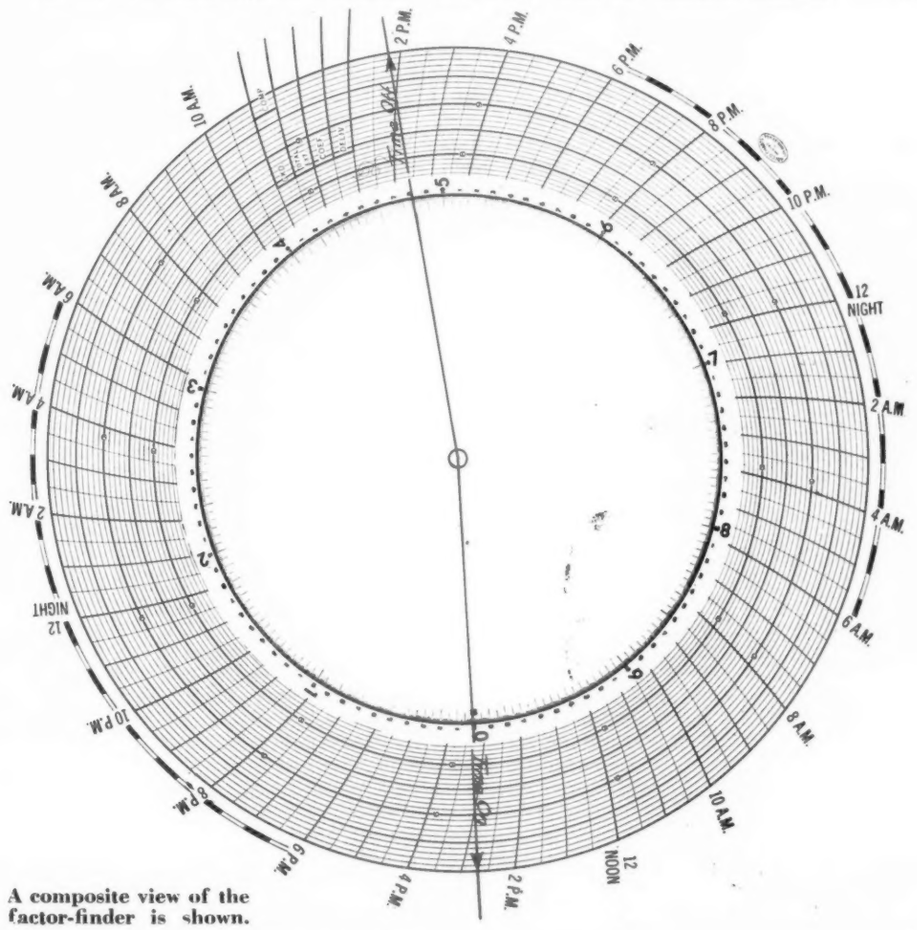
● **Operation.** Place "time on" indicator at the time the chart was placed on the meter gauge; move arm (the "time off" indicator) to the time at which the chart was removed from the meter gauge, and read *divisor* where C/L of arm crosses the percentage scale. The reading on the upper disk shows the relationship of the time on to the whole chart period. If the time on is more than the whole chart period, place "1." before the reading on the upper disk. For instance, if the reading is 2565, the divisor will be 1.2565.

● **Example.** Given: "Time on" is 2:42 p. m. on the 15th day of the month; "time off" is 1:50 p. m. on the 16th day of the month; total chart period is 48 hr.; square root planimeter reading of static is 3325.

Required: Average square root of static for time chart was on meter gauge.

Procedure: Place "time on" indicator at 2:42 p. m. (first day); move arm to 1:50 p. m. (second day); read 0.481 where C/L of arm crosses percentage scale.

3325/.481 = 6913 = average square root of static for time chart was on meter gauge. ★★



A composite view of the factor-finder is shown.

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Experimental flowing of oil wells on air-injection projects in Pennsylvania

BRUCE F. GRANT[1] **and ROBERT B. BOSSLER**[2]

EXPERIMENTAL work has been in progress for the last two and a half years to determine the feasibility of utilizing the reservoir energy created by air or gas injection to flow the oil from producing wells on secondary recovery projects in Venango County, Pennsylvania, district.

Although similar work has been done previously in other areas,[3, 4, 5] the experimental conversion of producing wells from pumping to flowing in this area was begun in August, 1943, by the Brundred Oil Corporation, Oil City, Pennsylvania, on one of its air-injection projects in the Oil City field. The assistance of the Petroleum Field Office of the Federal Bureau of Mines, Franklin, Pennsylvania, was requested in January, 1944, and a detailed engineering report covering the work will be published at a later date. The purpose of this article is to meet the more immediate need for general information on the work being done and to supplement the brief articles[6, 7] that have appeared to date.

More recently, other operators have undertaken flowing experiments, and at present information is being collected on the behavior of 77 wells that have been equipped with flowstrings by seven companies on 18 air-injection projects in this area. These data are being studied to determine the proper design and operating limits of equipment for flowing the wells and to evaluate the effect of flowing on the production characteristics of the reservoir and the operation as a whole.

On these projects oil is produced from the Venango sands (Upper Devonian) at depths ranging from 300 to 1000 ft., and daily oil-production rates range from 0.1 to 2.5 bbl. per well, with produced gas-oil ratios varying from 1000 to well above 10,000 cu. ft. per bbl. of oil. On these and other air-injection projects in the area, operating expense per barrel of oil produced by conventional methods is high, and the necessary maintenance of pumping equipment accounts for a large part of this expense.

It was believed that converting the producing wells from pumping to flowing would offer the possibility of reducing these operating costs and at the same time might result in decreased "bypassing" of the injected medium, which would result in more efficient recovery. These advantages may follow the conversion of wells from pumping to flowing provided that:

(1) Enough pressure can be established and maintained in the reservoir by air or gas injection to cause the wells to flow.

(2) The design and installation of flowstrings can be made practicable for the range of conditions found on a particular property.

(3) Oil-production rates to be expected from flowing the wells are not materially less than those obtained by pumping the wells.

(4) Flowing the wells will lower operating costs sufficiently to repay the costs of converting the wells from pumping to flowing.

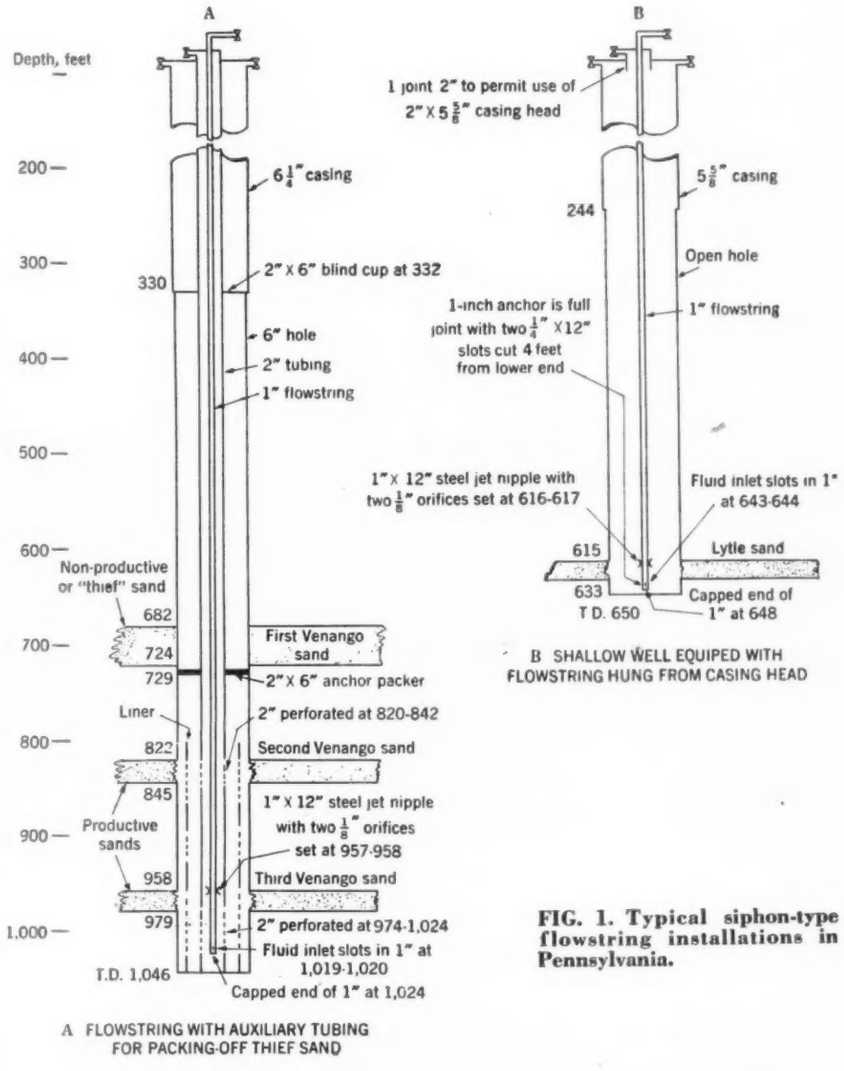

FIG. 1. Typical siphon-type flowstring installations in Pennsylvania.

[1]Petroleum engineer, U. S. Bureau of Mines, Petroleum Field Office, Franklin, Pennsylvania. Article published by permission of the Director, Bureau of Mines, U. S. Department of the Interior.

[2]Petroleum engineer, Brundred Oil Corporation, Oil City, Pennsylvania, and consulting petroleum engineer, Bureau of Mines, Oil City, Pennsylvania.

[3]"Wells in Old Field Produce Through Small Tapered Tubing," K. C. Sclater, *The Petroleum Engineer*, April, 1932, p. 14.

[4]"Repressuring Eastern Kentucky Area Makes Old Pumpers Flow," J. C. Albright, *Oil Weekly*, February 26, 1932, p. 25.

[5]"Restoring Pressure in Old Texas Field Flows Wells Regularly," Lawrence E. Smith, *National Petroleum News*, November 7, 1928, p. 27.

[6]"Flowing Producing Wells in Secondary Recovery, R. B. Bossler, *Independent Monthly*, May 1944. Reprinted in *Producers Monthly*, May 1944, *The Petroleum Engineer*, Reference Annual, July 1, 1944, p. 130.

[7]"Installation Used in Flowing Repressured Air-Gas Wells by Means of Reservoir Pressure," *Producers Monthly*, October 1944, p. 11.

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The first of these provisions is that the physical energy of the gas produced with the oil from each well must be enough to lift the fluid production to the surface. The physical energy of the gas depends on both its volume and pressure. Thus, if the shut-in pressure of a producing well exceeds the pressure required to flow, and, if at a back pressure equivalent to the expected flowing pressure, the well produces enough gas to lift its fluid, then the well may be expected to flow when equipped with a properly designed flowstring. The theoretical pressure distribution between an input and a producing well on a gas-injection project is such that more than half of the total pressure drop between input and producer takes place within 10 to 20 ft. around the producing well. By closing in producing wells shut-in pressures have resulted that often exceed 50 per cent of the input pressures. In more permeable sands where the injection pressures are less than the expected flowing pressure, a period of pressure restoration will be necessary to bring about flowing conditions. Such an experiment is planned on a lease in the Venango area to determine the feasibility and economics of increasing the average sand pressure by 100 lb. per sq. in. in order to allow the wells to flow. The pressure required to flow a well varies widely, depending on depth, oil, water, and gas-production rates and diameter and design of flowstring, but the performance of well studies indicates that the minimum pressure for continuous flow is approximately 8 to 10 lb. per sq. in. per 100 ft. of depth. The "kickoff" pressures required in intermittently flowing wells (flowing by heads) are dependent on relative gas and fluid production rates and flowstring design rather than on well depth but appear to fall within a range of 10 to 15 lb. per sq. in. per 100 ft. of depth.

The correct design of a flowstring involves consideration of a number of variables, such as depth, shut-in pressure, and rates of gas and liquid production. To lift the comparatively small daily oil and water output of wells in this area, several flowstring designs have been tried, and data are being obtained on experimental installations to define the various factors that affect their design and installation. The fact that injected and produced gas-liquid ratios are usually above 2000 cu. ft. per bbl. makes it unnecessary to design flowstrings for maximum lifting efficiency. This permits the use of a simple, uniform design for a wide variety of conditions; however, well performance data have indicated that it is desirable to design the flowstring so that the well flows by heads, or intermittently rather than continuously, because paraffin deposition is less and in some cases increased oil production at decreased gas-liquid ratios is obtained when wells that had been flowing continuously are made to flow intermittently. This desirable effect is attributed to the high pressure drop from the reservoir to the well bore during the low-pressure cycle of intermittent flow.

The type of flowstring that has proved widely applicable to wells in the Venango County area are illustrated in Fig. 1 (A and B). It is similar in design to the commonly used gas-well siphon.[8] Fluid inlet slots are milled into the bottom joint of the flowstring about 5 ft. from the capped end, and a "jet nipple" with two $\frac{1}{8}$-in. orifices is placed some 20 to 40 ft. above the fluid inlets. Fig. 1 (A) shows a 1-in. flowstring run with an auxiliary string of 2-in. pipe having a packer placed to shut off a barren, thief sand in the open hole above the two productive sands. Flowstrings have been installed as shown in (B) in wells having no thief sands, although in wells over 1000 ft. deep an auxiliary string of 2-in. tubing should be run when flowstrings 1 in. or smaller are used to prevent expensive fishing jobs should the flowstring be dropped.

Although the relation of operating limits to the length and diameter of siphon-type flowstrings is not clearly defined by work to date, 1-in. siphons are satisfactorily flowing 0.1 to 2.5 bbl. of liquid (oil and water) daily from wells 700 to 1000 ft. deep at gas-liquid ratios ranging up to about 8000 cu. ft. per bbl. (daily gas production rates up to 15,000 cu. ft. under some conditions). For higher gas-production rates, or higher gas-liquid ratios such as are encountered in badly bypassed wells, intermittent flow can be achieved only through the use of larger-diameter ($1\frac{1}{4}$ or $1\frac{1}{2}$-in.) pipe or combination strings of 1-in. and 2-in. pipe where the ratio of the lengths of each diameter is adjusted according to the capacity of the well. Experience has shown that wells flowing at gas-liquid ratios below 5000 cu. ft. per bbl. perform most satisfactorily and require the least attention. Designing flowstrings for the control of bypassing or high-ratio producing wells is more difficult, and stop-cocking may prove to be the most practical method of handling wells of this type.

Of the wells so far equipped with flowstrings, 58 have 1-in. siphons, 6 have $1\frac{1}{4}$-in. and 5 wells are flowing with combination or tapered strings of 1-in. and 2-in. pipe. One well is equipped with a conventional open-end string of 1-in. having no jets and 8 wells are equipped with modified chamber lifts so that they may be either air-lifted or allowed to flow themselves.

Data comparing oil, water, and gas-production rates before and after conversion from pumping to flowing are available for individual wells on only a few leases. Oil-production rates of a few wells have been slightly less by flowing than when pumping, whereas oil-production rates of the other wells have been either unchanged or increased by flowing. Marked decreases in produced gas-liquid ratios as a result of flowing were noted where comparative data were available. At present these indicated results cannot be applied beyond the boundaries of the leases on which they were ob-

[8] Williams, I. B., Brandenthaler, R. R. and Walker, Morgan, "Design and Operation of Gas Well Siphons," *Bureau of Mines Tech. Paper 460*, 1929, 45 pp., 12 figs.

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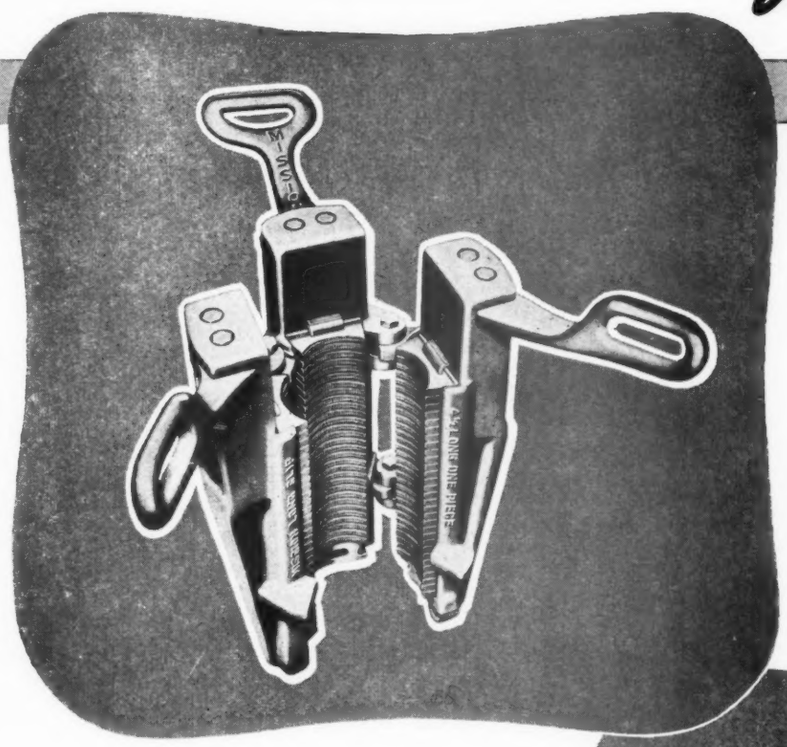

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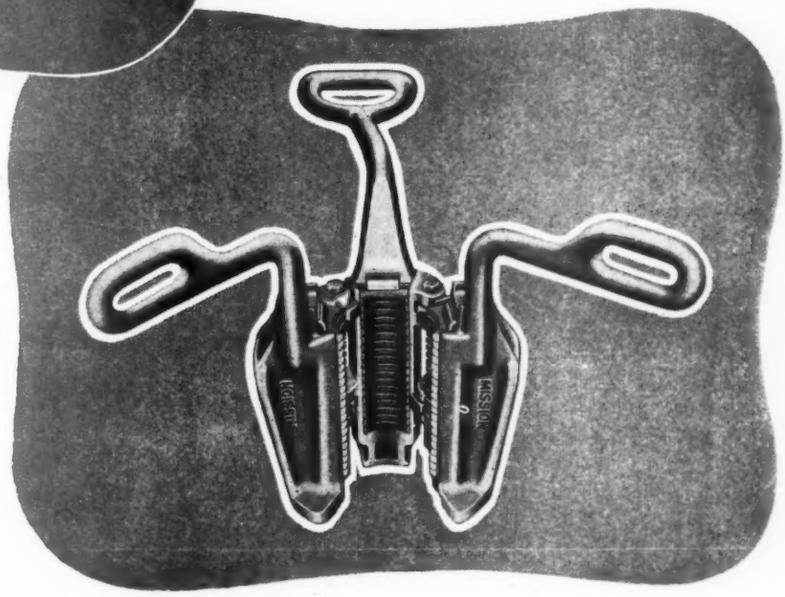

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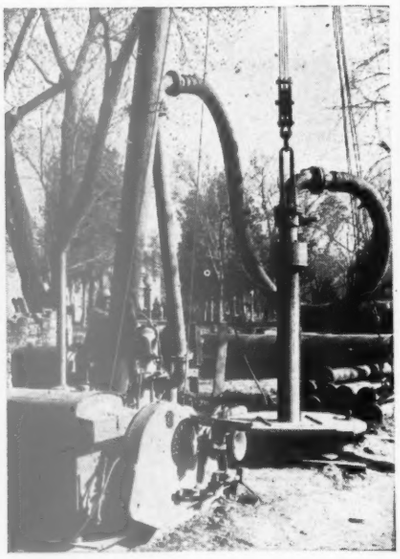

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tained, but they do provide the incentive for further experimental work.

Most of the data on the operating problems and economic results of flowing are based on a group of 24 flowing wells on one air-injection project, because the work on other leases has been confined to experimental installation of flowstrings in only one or two wells on each lease. On this project continuous production records have been kept for a 20-month period on a group of 16 flowing wells. During the 20 months only four pulling jobs have been necessary to repair or change flowstrings in the 16 wells, and this is a marked reduction in well pulling expense on the lease.

During the course of experimentation, failures have occurred, and several problems have arisen. For example, wells have failed to flow when the shut-in pressure was insufficient for flow and it was inadvisable to increase the pressure on offsetting injection wells, or where irregular operation of injection wells precluded the possibility of increasing the average sand pressure. Some of the problems that have developed in operating flowing wells are:

(1) The control of badly "channeled" producing wells having excessive gas-fluid ratios.

(2) The creation of water-in-oil emulsion in flowing the more viscous crude oils.

(3) The formation of paraffin deposits in the flowstring.

(4) The need for occasional air-lifting to kick off "dead" wells.

Although neither paraffin nor emulsion have proved serious so far, the extent to which they would affect wells in other areas is unknown.

Because the successful conversion of producing wells from pumping to flowing is limited to a few properties in this area, the feasibility of flowing other projects is necessarily judged by their similarity to the leases where flowing has been successful. To roughly appraise the possibilities of flowing the wells on a particular gas-injection property, the following information is necessary:

(1) Location, depth, spacing of wells.

(2) Pressure and volume of gas injected into each input well or zone.

(3) Twenty-four hour shut-in pressures of all producing wells.

(4) Oil-, water-, and gas-production rates of each producing well.

(5) Core analyses of producing sand, if available.

(6) Representative well-completion data on input and producing wells.

The first four items provide information on the injection operations and the probable pressures and volumes available for flowing. If flowing is contemplated, there must be stabilized injection to the sand through an adequate number of input wells so distributed as to leave no low-pressure areas in which wells will not flow, as no important decrease in operating costs can be expected if central pumping equipment must be maintained for part of the producing wells on a lease. If these operating data on the project conform to the general conditions previously outlined, it may be possible for the producing wells to flow their production. Flowstrings are designed on the basis of gas and liquid production rates of the wells, their logs, and completion data.

The effect of flowing the producing wells is known quantitatively on so few air-injection properties that conversion of wells to flowing on other leases should, as a first step, be confined to a few wells grouped to serve both as a pilot operation and, if results are favorable, as a nucleus for expansion. The planning, installation, and operation of these experimental groups preferably should be under engineering supervision so as to develop the maximum amount of information on the physical and economic comparison between flowing and pumping.

These studies by the Bureau of Mines will be continued and extended to other local air-gas injection projects where operators are interested in determining whether the reservoir energy created by the injected air or gas is sufficient, after having moved the fluid through the sand into the producing wells, to lift that fluid to the surface and into the stock tank. As a method of operation, flowing the producing wells, together with the best possible injection techniques, offers the possibility of lower operating costs and more efficient recovery of oil from air or gas injection projects in the Venango County district.

● **Acknowledgements.** The work upon which this paper is based was conducted by the Bureau of Mines under a cooperative agreement with the Pennsylvania Grade Crude Oil Association. The studies were made under the general supervision of R. A. Cattell, Chief, Petroleum and Natural Gas Division, Bureau of Mines, Washington, D. C., and under the direct supervision of C. J. Wilhelm, former supervising engineer, Bureau of Mines Petroleum Field Office, Franklin, Pennsylvania, and now in charge of primary production engineering at the Petroleum Experiment Station, Bartlesville, Oklahoma, and Sam S. Taylor, supervising engineer, Bureau of Mines Petroleum Field Office, Franklin, Pennsylvania.

The cooperation of W. J. Brundred, president, and the office and field personnel of the Brundred Oil Corporation in the field tests is gratefully acknowledged. The cooperation also of the officials and personnel of eight other local oil companies during these studies is greatly appreciated.

The writers are grateful also to the following individuals for constructive review of the manuscript: W. J. Brundred, Brundred Oil Corporation, Oil City, Pennsylvania; and to C. C. Anderson of the Washington office and Sam S. Taylor of the Franklin office, both of the Bureau of Mines. R. L. Rough, Bureau of Mines, Franklin, a cooperative employe of the Pennsylvania Grade Crude Oil Association, assisted in the field work.

The illustration was prepared by the Graphic Services Section, Central Experiment Station, Bureau of Mines, Pittsburgh, Pennsylvania. ★★★

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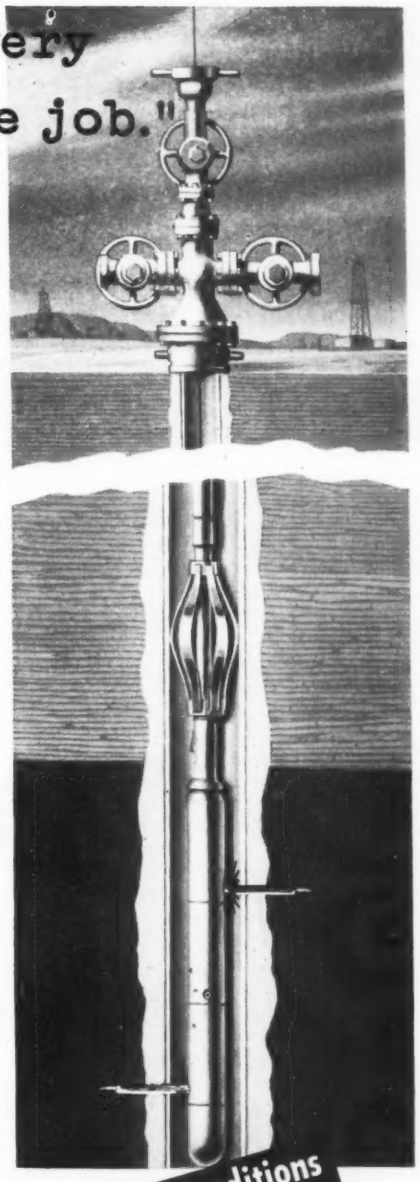

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Stainless steel in the petroleum industry*

By **JOHN S. EWING,** Stainless Steel Division,

Carnegie-Illinois Steel Corporation, Subsidiary of United States Steel Corp.

THE war has had a very definite influence on the type of development work that has been carried on by the steel industry. Normally, new steels are developed to meet market demands, operating conditions, or to achieve manufacturing economies. Full consideration could not be given to such incentives during the war period. In the case of the oil industry, engineers in many instances even had to forget economies of operation. For example, if a straight carbon steel would do the work of an alloy steel with more frequent replacements, the straight carbon steel was used.

Limited availability of the raw materials used in the manufacture of alloy and stainless steels resulted in two problems that were adequately solved. For years there had been no limit in alloy additions to a steel as long as the engineering requirements were satisfied. Suddenly steel producers were confronted with a demand for alloy and stainless steels far beyond any previous experience, a definite scarcity of the important alloys necessary for the manufacture of such steels, and no relaxation in the engineering requirements. There is an interesting story behind the successful solution of this problem. The result was, of course, the now well-known "NE' steels. The tremendous tonnages of alloy steels used during the war compounded the other problem. Fabrication of these tonnages resulted in a large accumulation of alloy steel scrap. Methods were devised for the utilization of this scrap with the maximum recovery of the contained alloys. The result was a conservation of scarce raw materials.

There was a tremendous amount of research done during the war period. All this work was to further a war economy. It is too soon to predict the extent to which we can apply the vast knowledge acquired during this period to our civilian economy. For example, the alloy steel developed for armor piercing shot or homogeneous armor plate were a radical departure from the type of alloy steels previously utilized for these purposes. These new steels possibly may have far-reaching applications in our everyday business. Nevertheless, commercial experience with them is lacking and they must be tested by industry before they become widely used. This same condition holds good for many other steels and products.

Although many war-born steels, such as the "NE" series of alloy steels, have been well known, little has yet been said about a new type of stainless steel that promises to play an important role in your industry.

Prior to World War II, the need had been indicated for a steel with the corrosion resistance of the 18-8 type but capable of developing higher hardnesses and physical properties than are found in an annealed austenitic steel. This need was partially filled by the high tensile 18-8 but the development of the properties of this steel was through the medium of cold working a modified 18-8. This method could only be applied to a limited range of steel products such as sheets, light plates, etc. Fabrication was limited to bending, machining, and spot welding if the high physical properties were to be retained. The cold worked 18-8 is not an engineering alloy amenable to the full range of fabrication and subsequent heat treatment to develop physical properties. It cannot be forged and retain its high strength characteristics nor is it available in heavy bar sections capable of being machined.

To fill this gap, there was under development at that time a stainless steel that would be available in bars, billets, forgings, and heavy plates, could undergo normal fabricating operations such as forging and machining, and subsequently be heat treated to develop high hardnesses and physical properties. At the outbreak of the war it was still in the laboratory stages. Due to its revolutionary nature, this product, "Stainless W", was placed under secrecy restrictions that have only recently been lifted. Incidentally, the "W" does not refer to tungsten but rather to the plant, Wood Works, at which it was developed.

The war applications for which Stainless W was used were of a very limited nature. As a result, one of the most important factors in developing a new steel was, of necessity, omitted. We were unable to submit it to selected types of industry in order to gain a background of its actual capabilities under various operating conditions. The oil industry has many applications for a steel with the corrosion resistance of 18-8 yet capable of being hardened by heat treatment, as for example, in valves, pump rods, and pump bodies. We can at present only give you a description of the steel, its properties, and the results of meager fabricating experience. Experimental work, however, is being actively conducted and preliminary results are highly encouraging.

The composition range of Stainless W is approximately 0.07 carbon, 17 per cent chromium, 7 per cent nickel, 0.70 titanium and 0.20 aluminum. The other elements are present in normal amounts found in other steels. It is a precipitation hardening steel. Unlike normal 18-8, Stainless W is magnetic.

Certain of the physical properties, which are more directly dependent upon metallographic structure than upon chemical composition, approach those of ferritic 17 chrome. Examples are: Specific gravity, coefficient of thermal expansion and electrical resistivity. The difference in electrical resistance and thermal conductivity between the annealed and aged conditions of Stainless W is believed to be indicative of precipitation. The constant modulus of elasticity of Stainless W, as compared with the decreasing modulus of cold worked 18-8, is significant.

Stainless W, like other precipitation hardening materials, is heat treated in 2 steps: (1) Solution annealing: Heating to put the precipitation hardening constituents into solid solution in austenite, which upon cooling to room temperature transforms into ferrite, which is then supersaturated with the precipitation hardening constituent. (2) Aging (precipitation hardening): Reheating, upon completion of austenite transformation, to a temperature at which precipitation hardening constituents will precipitate out of the supersaturated ferrite and impart the desired change of properties.

The solution annealing temperature range for Stainless W begins at about 1200°F., which is 100-200°F. above the temperature at which the material begins to transform to austenite, and extends to approximately 2000°F. With increasing solution annealing temperatures, the hardness and yield strength of the unaged material increases slightly and passes over a peak at about 1700-2000°F., while the corresponding tensile strength simultaneously reaches a minimum value at about 1600°F. and then increases slightly with increasing temperature. Usually the minimum holding time at temperature is short, and on thin sections 5 min. at the higher annealing temperatures (1850 - 1950°F.)

*Presented before the Western Petroleum Refiners' Association, Fort Worth, Texas, March 26, 1946.

have been found satisfactory, whereas slightly longer times are recommended for heavier sections where it is more difficult to determine when the material has reached temperature.

On cooling, the rate of transformation of austenite to ferrite is inherently sluggish, and therefore care must be taken to be certain that transformation is essentially complete prior to aging. Two to four hours at room temperature following the 1700-2000°F. solution anneal is usually considered sufficient, but longer times are necessary following the lower solution annealing temperatures. The transformation may be followed by a series of hardness readings taken over a period of time.

Precipitation hardening takes place over the temperature range of 500°F. to approximately 1050°F. At the lower temperatures the aging reaction is slow and resultant material lacks ductility. Of the 3 recommended aging temperatures, 950°F. gives the maximum tensile and yield strengths, but the lowest impact strength and ductility, whereas 1000°F. gives a slightly lower tensile and yield strength with an improved impact strength and ductility. Aging at 1050°F. results in the formation of some austenite, which improves the ductility and impact strength, but at some sacrifice of tensile and yield strengths. The heating rate to the aging temperature does not have an appreciable effect upon the resultant mechanical properties, but the cooling rate from the aging temperature has a very pronounced effect upon the impact strength, which is markedly improved by rapid cooling.

One of the most interesting characteristics of Stainless W is the extreme uniformity of hardness, in both unaged and aged conditions, obtainable over cross-section of bars of various diameters.

Stainless W in the solution annealed condition will show mechanical properties of the order of 125,000 lb. tensile strength, 100,000 lb. yield strength, 8 per cent elongation in 2 in. and a hardness of approximately 25 Rockwell C. Depending upon the aging temperature, mechanical properties can be obtained in the neighborhood of 200,000 lb. tensile strength, 175,000 lb. yield strength, 8 per cent elongation and a Rockwell hardness of 40C. Complete information regarding the full range of properties is available on request.

The Izod impact strength of Stainless W in the unaged condition is approximately 40-60 ft.-lb., regardless of the solution annealing temperature. Upon aging, however, the solution anneal prior to aging and the cooling rate from the aging temperature will have a bearing upon the resultant impact strength with the faster cooling rates favoring better impact properties.

The endurance ratio for the unnotched specimens is approximately 0.46 based on a tensile strength of 195,000 lb. per sq. in., and approximately 0.20 for the notched condition. Results of other tests indicate the unnotched value to be, conservatively, about 96,000 lb. per sq. in., for aged material.

At temperatures above 800°F. the strength of Stainless W is about the same as that of annealed 18-8; however, at moderate temperatures, the strength imparted to Stainless W by the precipitation hardening process is maintained and may be utilized.

Standard embrittlement test shows that Stainless W is not susceptible to intergranular corrosion. Likewise, the metal resists the salt spray test about as well as standard 18-8. When immersed in sea water, no appreciable difference in corrosive attack was observable between the annealed 18-8 and 18-8 Ti controls and the Stainless W in either the solution annealed or aged conditions. After 3½ years of exposure, it appears that Stainless W has approximately the same resistance to atmospheric corrosion as does 18-8. A limited amount of preliminary data from service and simulated service tests on Stainless W valve parts in hydrogen sulphide gas, sulphur dioxide gas, and hot milk, indicate corrosion resistance equivalent to the 18-8 types of stainless steels in many media.

There are indications that the steel can be machined in about the same manner as the free machining 18-8 although there is not much information as yet available on tool life. The forging characteristics of the material are similar to those of the normal 18-8. The mechanical properties of Stainless W in the solution annealed condition are such that it will not withstand extreme cold deformation.

The spot welding characteristics of Stainless W are approximately those of 18-8, which are excellent.

As the properties of Stainless W are a function of the chemical composition and heat treatment, the properties of welded joints will also depend upon these variables. The problem of depositing weld metal of chemical composition similar to that of the parent metal, particularly with respect to titanium, was solved by the development of suitable flux coating for Stainless W core wire. The special electrodes were subjected to a number of welding tests and show that:

1. The "as-welded" strength of joints in solution-annealed sheets and plates is about the same as that of the unwelded material, i.e. 100 per cent efficiency.

2. The "as-welded" strength of the joints in aged sheets and plates is about 70 to 80 per cent of that of the unwelded material.

3. The strength of joints given post heat treatment of aging only, was erratic particularly on specimens on which the weld bends were not ground flush, and varied from the strength value of solution annealed material to that of fully aged material.

4. Solution annealing and aging after welding produced strengths across the welded joints exceeding 90 per cent of the strength of fully aged parent metal. The hardness values show that the heat resulting from the deposition of the second bead has an effect on the aging response of the first bead.

In general, the results are very favor-

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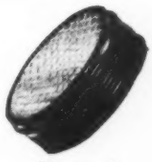

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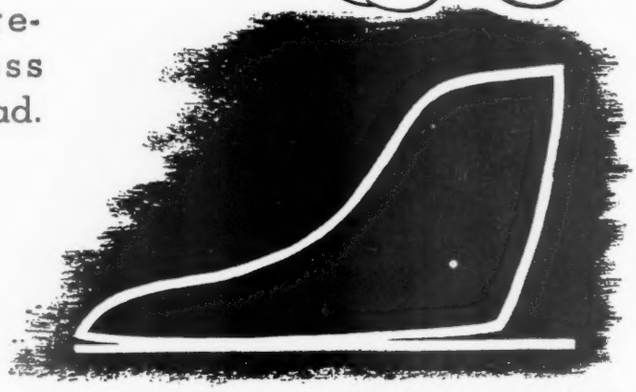

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able and show that Stainless W can be readily joined by the process of metal arc welding and high joint efficiencies obtained, particularly when solution annealing followed by aging is employed as a post welding heat treatment. Further work on the aging characteristics of single and multiple welds is now in progress. Welding by means of the atomic hydrogen and heli-arc methods is now being investigated and preliminary results have been successful.

There is every indication that Stainless W can be utilized to advantage by the oil refining industry. The material is available at the present time in all of the normal wrought forms and test samples can be furnished for investigation.

Prior to 1942, the oil refining industry as a whole was very active in its demands on the steel industry for steels to meet various operating conditions. Much of the testing of new steels by your companies had to be omitted during the ensuing 4 years. I do not believe it would be amiss to review briefly some of the applications that were meeting with success prior to the war period.

Economical protection against corrosion in reaction chambers, flash towers, evaporators, coking drums, vacuum towers, bubble towers, and heat exchangers may be obtained by applying thin sheets or strips of stainless steel to the inner surfaces of the units, the material being applied either in the shop or in the field as may be most suitable. Under ordinary conditions in hot end service, 12 per cent chromium steel will provide adequate protection to the equipment, but where exceptionally severe conditions exist, the 18-8 or 18-8 Mo types should be used.

Stainless steel linings serve to insulate the shells to some extent and thus aid in preventing distortion or cracking when the vessels are being cooled rapidly. This action serves to cut down the time off stream and in many cases is, in itself, a sufficient reason for the application of stainless steel liners.

More and more stainless and heat resisting steel is being used for refinery valves and trim. Martensitic stainless steel, such as the 12 per cent chromium type, which can be hardened by heat treatment, finds extensive use in hot end applications where corrosion conditions are not too severe. Many operators, however, prefer to use the same type of equipment throughout the plant, and as a result, must use a steel that will stand up under the attack of cold end corrosive products. For such use, the austenitic type 18-8 chromium-nickel steels are giving very satisfactory results in valve trim. The long life of such valves in hot end service and the convenience and economy of maintaining a smaller stock of replacements frequently justifies the somewhat higher prices of the valves made of the more corrosion-resistant steel. It is quite possible that the new Stainless W will find important applications in this field.

The experience gained in other fields has made it possible to fabricate stain-

Thinking it Through!

[NO. 5 OF A SERIES]

The Proposition **Provision for recycling gas oil should be included in any design for Fluid cat-crackers.**

The Facts Passing any material through a given piece of process equipment more than once at less than the maximum performance level would not, at first glance, appear to be a most economical use of that equipment. However, in cat-cracking, if maximum cracking is attempted in one contact of oil and catalyst, undesirably high percentages of coke and dry gas are obtained in the cracked products.

Experience has proved that for optimum product distribution about half of the fresh feed should be cracked during the first contact with catalyst. Yet experience has also proved that for maximum overall return from feed stock about three-fourths of the average charge should be converted into light products.

Both of these requirements can be satisfied through use of a recycling operation...achieving a high overall yield of profitable products without concurrent waste of feed stock due to over-cracking.

Thus for overall conversion efficiency . . . today and tomorrow . . . provision for recycling the gas-oil fraction is of utmost economic importance.

The Conclusion **There is no substitute for the *best* design.**

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less steel bubble trays economically and consequently they can be used for most types of high temperature service instead of being restricted for use only in those applications where severe corrosive conditions are encountered. Good design holds weight to a minimum while the corrosion resistance of the metal minimizes attack and its toughness holds breakage to a point sufficiently low not to interfere with the economic operation of the unit.

When stainless steel is used for bubble tray construction, experience shows that the towers can be put on stream or cooled down for cleanout and inspection more quickly. Being lighter in weight, stainless steel trays have less heat capacity than cast-iron trays, thus making it possible to change temperatures without the delay normally attendant upon "circulation" to adjust temperatures.

Hot end applications, where temperatures range from 400° to 1000°F., may ordinarily be handled with 12 per cent chromium stainless steel, which has sufficient corrosion resistance to meet the conditions encountered where liquid water is absent. Strip tests, however, are recommended for cold end applications to make sure that the steel selected will have sufficient corrosion resistance to meet the specific conditions encountered and at the same time possess the other properties necessary.

Because of their light weight, stainless steel bubble caps have been widely used in natural gasoline plants handling sour gases, in absorbers and stabilizers, and in crude, vacuum, and pressure distillate (cracking) bubble towers. They are easily fabricated because of the tough and ductile character of the metal and sharper fractionation is more easily attained because there is little or no danger of towers being operated with caps having broken teeth.

Stainless steel bubble caps are not normally susceptible to coking through corrosive action. Consequently, towers are on stream longer; down time for cleaning is shorter; less labor is involved. Inasmuch as towers equipped with stainless bubble caps are free from fouling, pressure drop remains constant, a better production and better operation result.

More caps per tray, or a smaller tray containing the same number of caps, can be installed when stainless steel is used for the bubble caps. Being extremely thin and easily punched, stainless steel bubble caps can be made with more teeth, which aids in obtaining a more intimate mixture of the vapor and the liquid on the tray.

Pump rods are now being made of 18-8 stainless steel because of its toughness and resistance to corrosion. Heat-treated 12 per cent chromium steel finds a useful place as impeller shafts for centrifugal pumps because of its desirable combination of hardness and satisfactory corrosion resistance. Plungers in hot oil pumps handling corrosive stocks have been made successfully of both 5 per cent chromium-molybdenum steel and of 18-8 stainless steel, the choice depending upon the degree of corrosive action of the stock being pumped. In many instances it has been found economical to make the entire pump body of stainless steel.

Exposed steel surfaces can be protected economically by the application of weld overlays, using 18-8 or 25-20 stainless steel welding rods. Such overlays not only guard the base metal against corrosive attack, but also protect it against erosion or washing action that may give trouble with the softer, less corrosion-resistant metals.

Other effective and economical applications of weld overlays include building up corroded, eroded, or wire-cut bodies of control or flow valves; facing flanges or building up the bonnets of valves, and lining spools, vapor line ends, junction boxes, headers, plugs and return bends. Hot oil pumps have been successfully built up by welding, as have plugs and bodies of plug cocks. Check valve bodies, and application inside the stainless trim on gate valves also afford other opportunities to make use of the economies that are possible through the use of stainless steel weld overlays.

It is impossible to list all the important applications of corrosion and heat-resisting steels. The principal applications have been outlined above, but there are a host of other important, yet relatively minor, applications of stainless steel around the hot end of any re-

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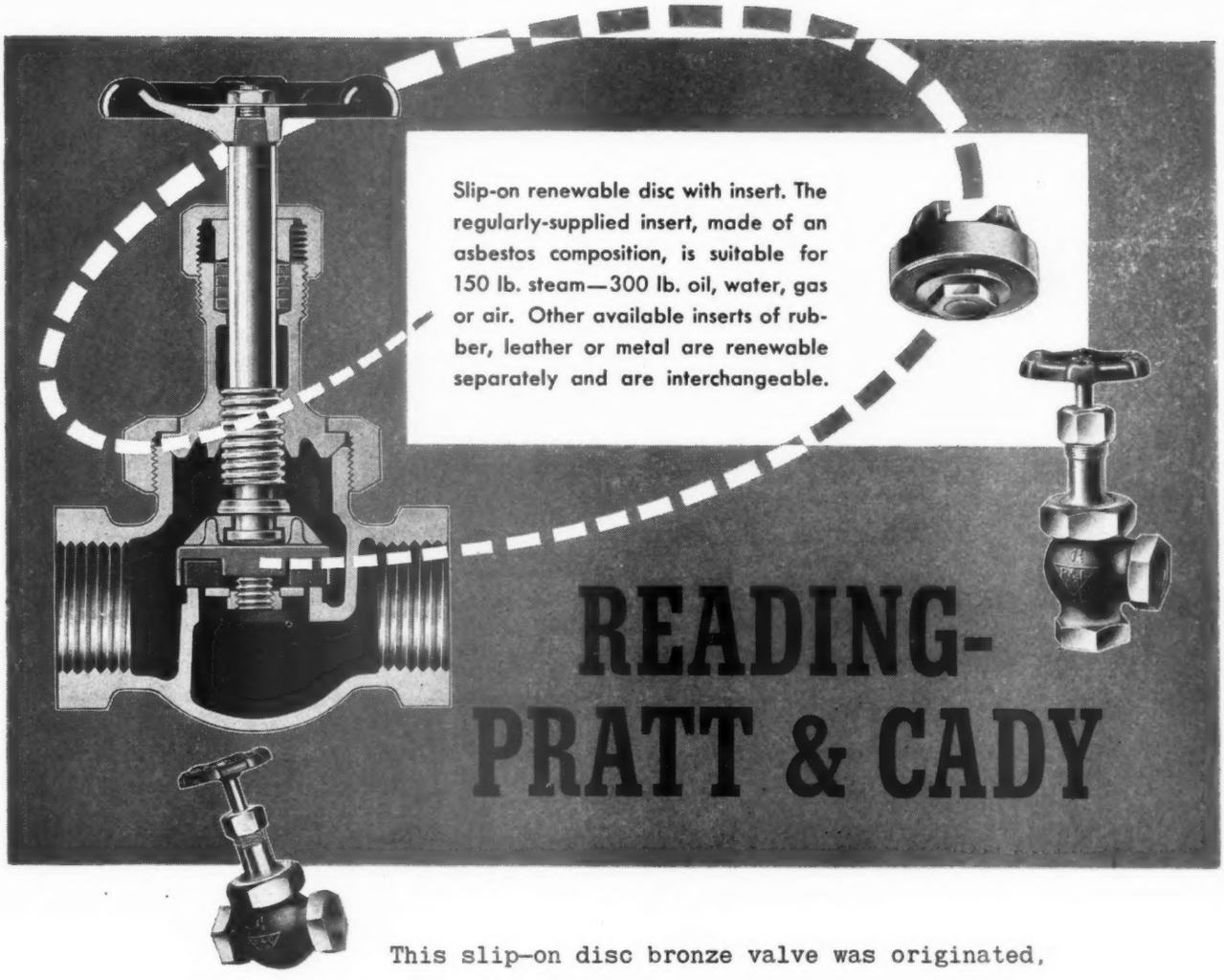
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finery. For example, the 12 per cent chromium and 18-8 stainless steels are now being used for liners in towers, nozzles, gaskets, and orifice plates. Thermocouple wells and ball floats fabricated from 18-8 stainless steel have given good service. Tube sheets, baffles, supports and spacers for heat exchanger bundles in many refineries are now being made from 5 per cent chromium steel, 12 per cent chromium steel, and 18-8 stainless steel according to the specific needs. When corrosive stocks have to be handled through heat exchangers, operators report good service from 5 per cent chromium-molybdenum and 18-8 stainless steel tubes. Other miscellaneous applications include tray support angles, rain decks, and baffles in bubble towers and evaporators.

Stainless and heat-resisting steels can be applied to good advantage in connection with furnace dampers, high temperature air preheaters, and gas recirculating systems, the type of steel to be used depending upon the conditions involved, including both temperature and degree of corrosive action possible.

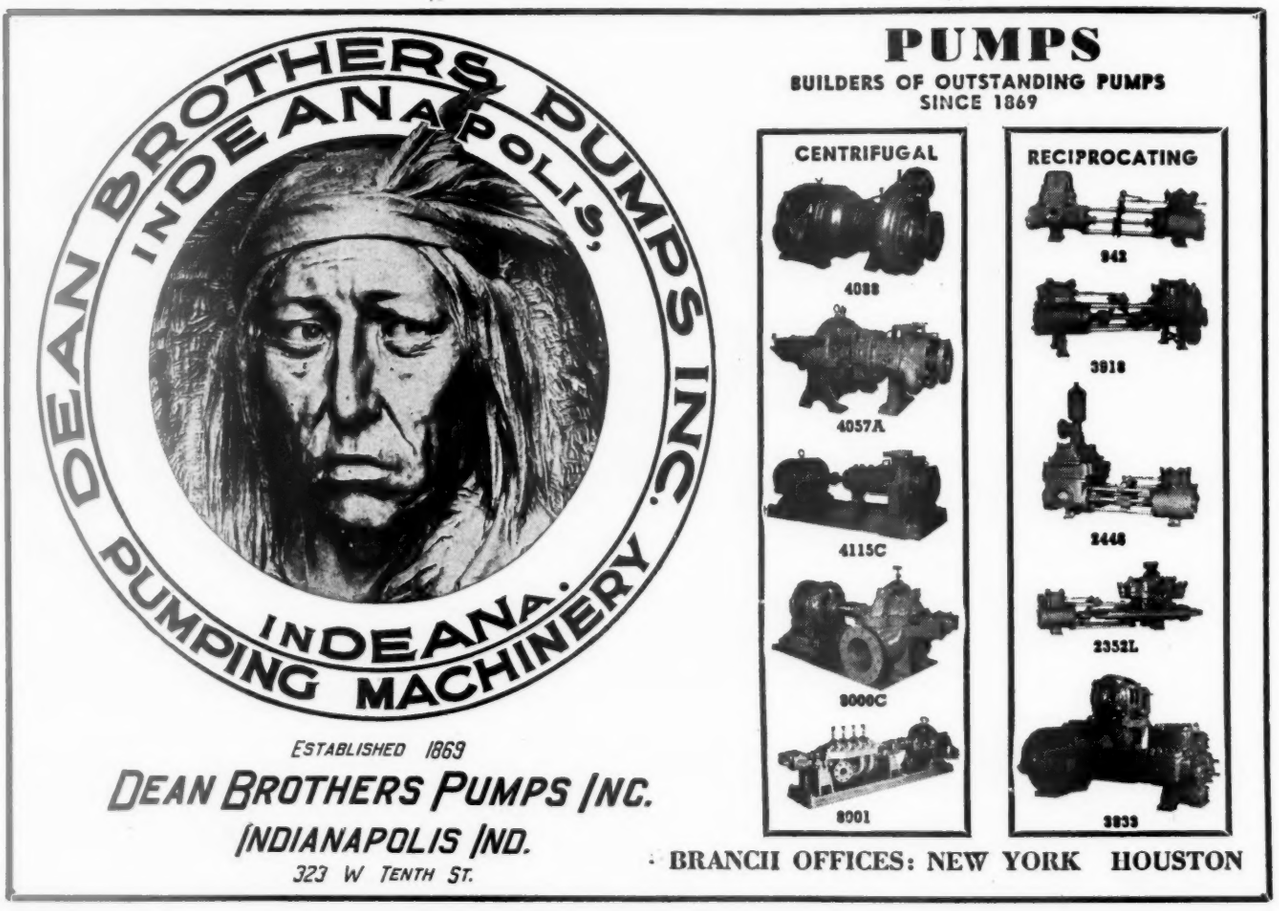
Under varying conditions, all the stainless and heat-resisting steels, including the 5 per cent chromium-molybdenum type, have given economical service in cold end refinery applications. Straight chromium steels, however, must be used with discretion when there is the possibility of hydrochloric acid being produced by the hydrolysis of salts such as magnesium chloride during the thermal treatment of the stock, or when SO_2 or SO_3 is present. An economic study of the whole problem should always be made, for the economy possible when the 5 per cent chromium-molybdenum or the 12 or 17 per cent straight chromium steels can be used is worth gaining, if possible. These steels have demonstrated their value in many instances where cold end corrosive action was not too severe.

Type 316 Stainless steel, which contains approximately 2 to 3 per cent of molybdenum in addition to 18 per cent chromium and 8 per cent nickel, has given satisfaction in cold end service. This type of stainless steel shows a corrosion resistance at all times equal to that of the usual 18-8 stainless steel and where acids such as dilute hydrochloric, sulphuric, sulphurous, wet hydrogen sulphide, of phosphoric, as well as a wide group of the organic acids, are present, its appreciably greater corrosion resistance proves valuable. Trial installations have been highly successful and consequently the use of 18-8 Mo type of stainless steel is increasing rapidly in refinery applications.

Vacuum and pressure relief valves on storage tanks must function smoothly at all times for best results. Use of 18-8 stainless steel in these valves and seats will assure a smooth, dense surface and a perfect fit between the valve disk and the seat, thus making smooth operation of these important valves more certain.

No single type of stainless steel should be considered as a cure-all for all the corrosion or high temperature problems encountered in refinery operation. Each of the several types and grades now available has a place and the application of the right grade to the particular situation is a technical problem that must be considered from all angles. The final answer lies in attaining an economic balance between cost and operational efficiency. Technical advice should be sought from refinery chemists and operators in conjunction with the experience of the engineers and metallurgists whose services are offered by the companies making stainless steel. Their experience can safely be relied upon, for they have been confronted by corrosion and oxidation problems in many different guises and what may appear to be a major problem may often be solved by utilizing the information gained in solving a similar problem that was not so important in another plant, yet which had to be solved for fully satisfactory results of the installation as a whole. Information of that kind cannot be assembled into standard recommendations as there are so many complicating factors.

In closing, it should be reiterated that in many cases new steels result from a demand by industry. Applications of old or new steels can only result from your making known to the steel manufacturer your requirements. ★★★



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(1) *Drill pipe protectors*

The new patented Bettis fluted type drill pipe protectors are designed to give maximum protection from wear to oversize tool joints in small casing, without restricting the return flow of the circulating mud. The fluid passes easily through the streamlined spiral channels, as shown in the accompanying illustration. Much less clearance can be allowed than when regular plain protectors are used.

These protectors are manufactured by Bettis Rubber Company of Los Angeles and are available in two sizes: For 3½-in. drill pipe, expanded on pipe to 5¼ in. O.D. for use in 7-in. O.D. casing; and 4½-in. drill pipe, expanded on pipe to 6⅝ in. O.D. for use in 8⅝-in. O.D. casing. Their greater O.D. and extra length make Bettis fluted protectors and stabilizers preferable for running in both casing and open hole under many conditions, the manufacturer states.

According to the manufacturer, these fluted protectors reduce torque and make for more accurate control of drilling weight; they reduce drilling and reaming operations; and, both in regular drilling and directional drilling work, they relieve friction and reduce wear to the minimum.

(2) *Bottle carrier*

A new cushioned, shock resisting bottle carrier, which is acid, caustic, and corrosion resistant, has been developed by Benson and Associates, 332 South Michigan Avenue, Chicago. It is specifically designed to minimize bottle breakage when handling and transporting bottled chemicals of a hazardous nature. It is impervious to broken glass and prevents leakage of injurious chemicals, indelible inks, dyes, stains, etc., should a severe blow cause the bottle to break.

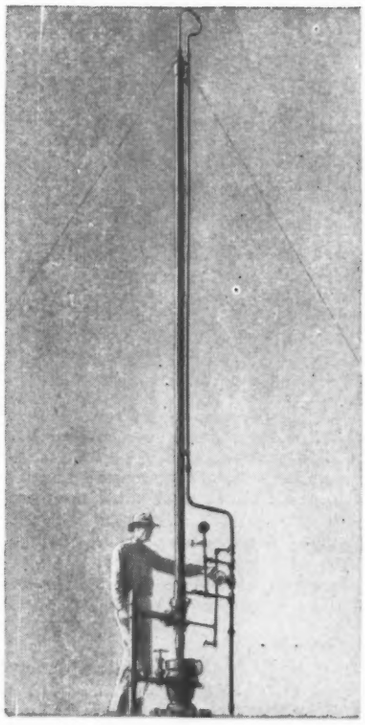
The bottle carrier is made of silver colored, impregnated, light weight fabric, and contains a shock absorbing resilient inner padding. The entire bottle is enveloped! A draw string at the top insures complete coverage to prevent an upward splashing. Two corrosion resisting fabric straps are vulcanized to and support the base, assuring a safe and comfortable means of carrying two or more bottles. The carrier is soft, pliable, and collapsible when empty. The removable padding and the carrier are easily cleaned.

Two sizes are now in production—for the 1-gal. glass jug and the 2-liter reagent bottle. This carrier can be designed for all size bottles.

The United States Rubber Company manufacturers this item exclusively for Benson and Associates.

(3) *Paraffin control*

A new, simple-to-operate method of controlling paraffin in pumping wells that greatly reduces pumping costs, where wax is a production problem, is announced by Kobe, Inc. It consists of a lift (see illustration) that has been developed to make use of the hydraulic power on the lease to raise and lower a series of scrapers positioned in the production tubing.



Operation is controlled by two valves at the base of the lift. When the top one is open and the bottom closed, the power oil flows through the top of the lift and down the well to actuate the pumping unit in the production tubing. When the bottom valve is open and the other closed, the power oil flows through the bottom of the lift, forcing the piston, attached to the top of the power oil tubing, upward in the lift. This moves the scrapers on the power oil tubing through the paraffin zone, loosening the wax, which can then be easily pumped from the well.

Periodic operation of the lift keeps the production tubing free of heavy wax deposits.

The new Kobe lift has been tested in numerous fields during the last two years and is now in commercial production.

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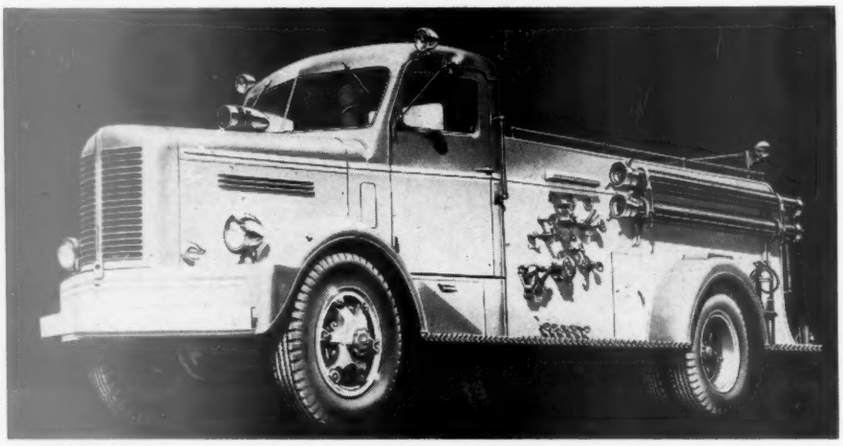
(4) *Fire engine*

Details of a new 750 gal. triple combination FWD fire fighter have been released by The Four Wheel Drive Auto Company, Clintonville, Wisconsin. The new Model F75T, developed as a standard FWD fire fighting unit, is the outgrowth of more than 30 years experience in custom-built fire truck manufacture.



The F75T, now in production, employs the FWD four-wheel-drive principle with a center differential that imparts a balanced tractive effort to all wheels. This feature gives the driver better steering control as wheel slippage and the tendency to skid is reduced. The powered front wheels pull in the direction steered, enabling the vehicle to take curves safely at higher speeds, the manufacturer states.

When difficult operating conditions are encountered and traction is lost, a manually controlled lock eliminates the center differential action and provides positive drive to both front and rear axles. With four-wheel-drive, the fire fighter is able to travel faster and safer on ice and can plow its way to the fire through mud and snow. In rural fire fighting, it can be driven across country, over plowed fields, through swamps, directly to a creek or lake or other water source.

Powered with a six-cylinder 190-b.hp. FWD engine, the Model F75T has a piston displacement of 525 cu. in. and develops 410 ft.-lb. of torque. The wheelbase is 160 in.

Equipped with an FWD centrifugal 750 gal. per min. two-stage series-parallel pump, the new fire engine features large volume-low pressure and reduced volume-high pressure performance controlled by means of a transfer valve.

The new open type all-steel body of 12-gauge steel with hardwood slatted removable floor has a capacity of more than 1200 ft. of double jacketed 2½-in. hose and 400 ft. of double jacketed 1½-in. hose. The fire department type ladders mount on FWD special ladder brackets that hold the ladders securely in place, preventing shifting and eliminating all rattle.

The F75T is designed according to the recommendations of a majority of fire chiefs. It has an open type body with all equipment and controls readily accessible. Suction hose, ladders, axes and pump controls are mounted or carried on the hose body in conveniently located positions.

The 150-gal. rust resistant water tank is located in the hose body. Equipped with splash surge plates, the tank has a 6-in. filler with sloping top forming a funnel for easy filling. The booster tank hose reel has a capacity of 200 ft. of hose and is optionally mounted over the booster tank or ahead of the rear step.

The Model F75T fire fighter is supplied complete with a standard group of approved accessories that include siren, searchlights, electric lanterns, pike pole, crowbar, extinguishers, axes, hydrant connections, and hose couplings.

(5) *Selector valves*

Hydro-Aire, Incorporated, 626 North Robertson Boulevard, Los Angeles, California, has recently engineered and is now manufacturing a complete series of industrial two-way, three-way, and four-way selector valves.

These valves were developed after extensive research into industrial requirements, and are capable of handling flows up to 2500 gal. per hr. with negligible pressure drop. Sizes range from ⅜ in. to 1½ in. Units incorporate patented sealing methods that are also used in critical aircraft fuel valves. The features of these valves are:

1. Extremely light weight.
2. Low operating torque.
3. Not affected by back pressures.
4. Suitable for use at temperatures ranging from minus 65°F. ot plus 200°F.
5. Small size for large capacity of fluid handled.
6. Can be used for any type of liquid.
7. Can be serviced easily by inexperienced personnel.

Valve can be positioned at 200 lb. per sq. in., and will withstand operating pressures of 1000 lb. per sq. in. A plug type design is used, thus insuring fewer parts and lower cost. Unit can also be supplied in small sizes for use in compressed air lines.

(7) *Diaphragm valves*

The Hammel-Dahl Company offers a full line of diaphragm control valves in sizes ½ in. to 1 in., in alloy construction, either in 304 or 316 stainless steel, or other special corrosion-resistant alloys obtainable in cast form.

A feature of these valves is the use of a single body casting for each size, this body construction being rated at 600 lb. maximum working pressure at 750°F., and also, in the use of split flanges giving a Van Stone type of joint for ASA pressure ratings of 150, 300, or 600 lb.

As with all Hammel-Dahl diaphragm control valves, the face-to-face dimensions are in accord with ASA Standards as covered by B16.10-1939 "Face-to-Face Dimensions of Ferrous Flanged and Welding End Valves."

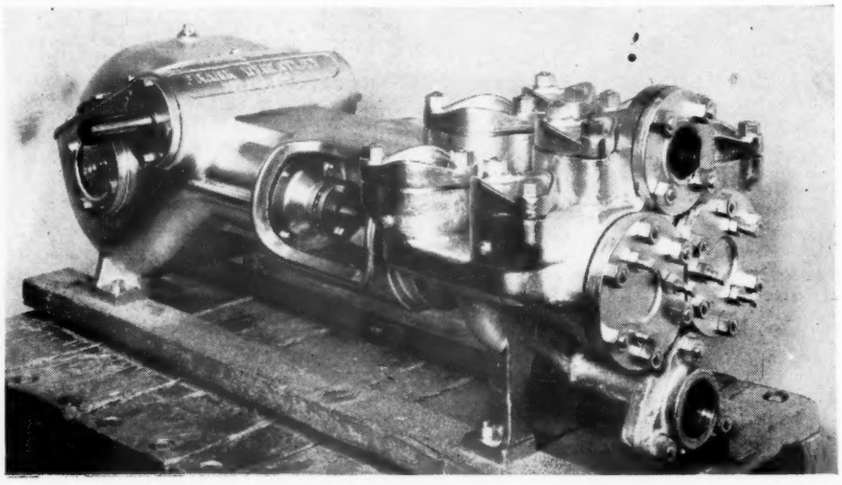
The use of the split flange construction eliminates the usual difficulty of obtaining sound castings in these alloys, it is stated. A further advantage of the split flange construction is that valves may be changed from point to point for use at different pressure ratings merely by replacing the removable flanges, the manufacturer says.

These valves incorporate the usual Hammel-Dahl features, such as, all-steel diaphragm superstructure with two-ply Neoprene diaphragm, valve position indicator, through-bolted stuffing glands, and stuffing-box lubricator and isolating valve. The standard air pressure operating range is 2-15 lb. per sq. in.; other ranges are available. For high temperature-service, airfin bonnets are available.

(6) *Aluminum pump*

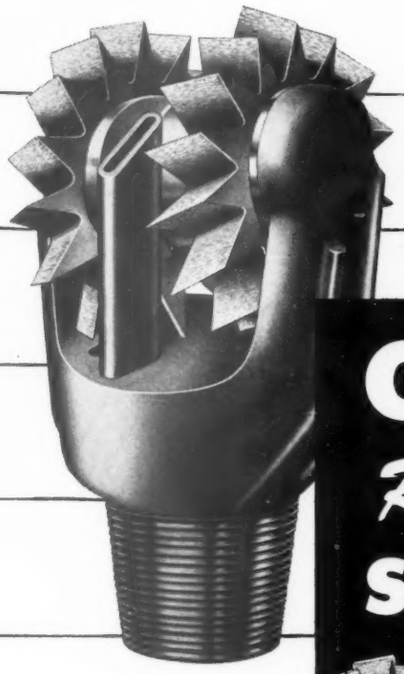
The new aluminum-type pump designed by the Frank Wheatley Pump and Valve Manufacturers, is the latest pioneering development of this company, which through the years has established a reputation for progressive pump improvement.

For truck-mounted rotary rigs, seismic shot-hole drills, and other services where the utmost in lightness and portability is desirable, the new aluminum pump attains great reductions in weight; in fact, it weighs only about one-third that of the conventional type, according to the manufacturers. These aluminum reciprocating pumps are to be manufactured in a full line of sizes and capacities for all fluid displacement purposes.

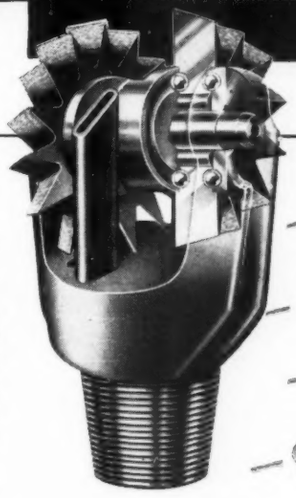


— so you want to dig shale!

— then use the improved



GRANT
Roller Cutter
SHALE BIT



— faster drilling
— full gauge hole
— long life
— greater economy

Designed for modern drilling methods the GRANT ROLLER CUTTER SHALE BIT is built to make hole under the highest speeds used in the oil fields today. Cutters are extra large and hardfaced for long wear. Worn cutter assemblies are easily replaced by any competent welder. Drilling time is greatly reduced, since this GRANT bit makes hole faster and lasts longer in shale digging. Specify GRANT.

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(8) *Floating roof*

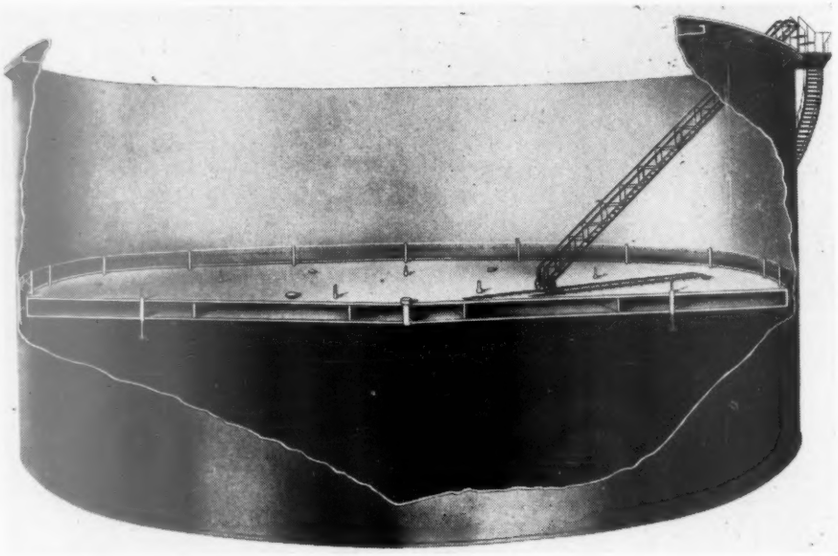
A new floating roof for use on storage and filling tanks of petroleum products has been announced by Graver Tank and Manufacturing Company, Inc. According to the manufacturers, the Graver pontoon floating roof offers several outstanding improvements and advantages, is exceedingly simple in construction, and is provided with a positive vapor seal.

It is said to be particularly efficient when used for the protection of finished products in tanks too isolated for practical manifolding to expansion roof tanks or in tanks where excessive differences in filling and withdrawal may exist, such as a water terminal.

It is said, also, that this roof is ideal for the protection of "sour" crudes. The roof lies entirely on the surface of the liquid and eliminates any vapor space and the possibility of corrosion.

The Graver pontoon floating roof has a double deck that is said effectively to insulate the stored liquid against boiling. It is built with a vapor-tight seal that consists of a heavily galvanized or stainless steel shoe to which is attached a synthetically treated flexible fabric. The shoe is held tightly against the tank wall by means of closely spaced spring-actuated arms. Furthermore, according to the manufacturer, the vapors collecting in the space between the roof and the tank wall further tighten the seal because of the lateral pressure they exert. When desired, a secondary seal can be installed.

The deck is designed to eliminate any pockets in which dirt or water might collect. The center drain is screened with pipe drain optional, and the roof is fitted with fully adjustable supports.



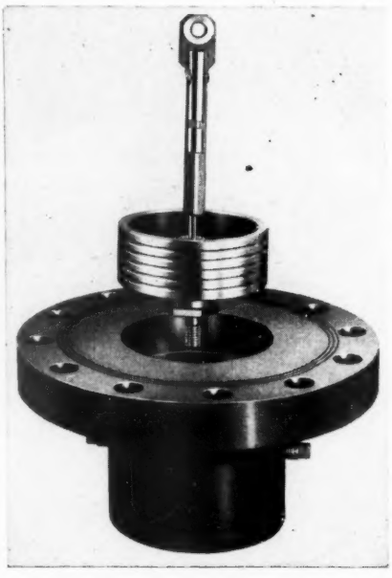
(9) *Metering hot liquids*

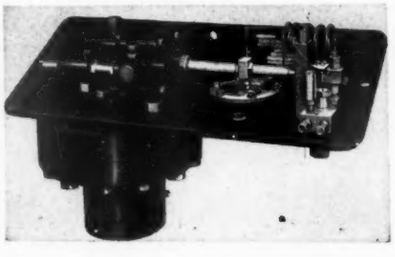
One of the accompanying illustrations shows a Republic pneumatic transmitter (with cover removed) designed for measuring the flow of hot liquids, which are so viscous at room temperature that they congeal in the lead lines. A piston is used instead of the ordinary diaphragm in order to avoid the effect of hot liquids on diaphragms. (Non-metallic diaphragms are not usable above 200°F., and metallic diaphragms might give very erratic results at high temperature.)

The transmitter is designed for installation in a manner that keeps the measuring chambers hot enough to prevent the measured fluid from congealing in the transmitter chambers and lead lines. The piston and cylinder are made of steel of the same composition, so that the clearance is maintained regardless of temperature changes.

Republic piston type transmitters are now being used for the measurement of coal tar pitch at a flowing temperature of 550°F., and the flow of petroleum tar at 600°F.

Republic Flow Meters Company, Chicago, Illinois, is the manufacturer.





A WISCONSIN HEAVY-DUTY *Air-Cooled* ENGINE *is an Important Part of the Picture*

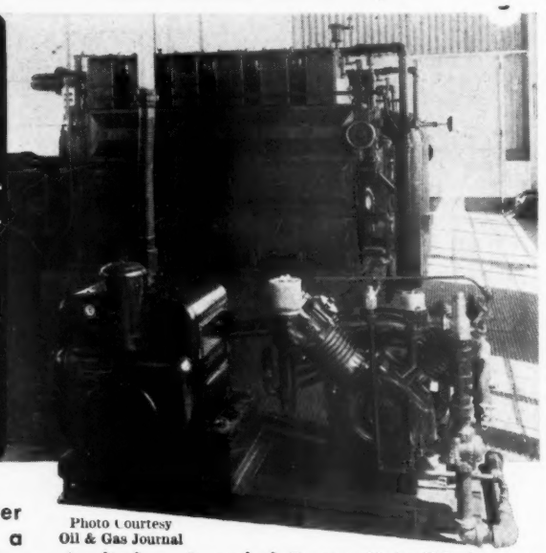


Photo Courtesy Oil & Gas Journal

This clean, efficient power plant installation shows a Model VE-4 Wisconsin V-type, 4-cylinder air-cooled Power Unit (22 hp. at 2600 R.P.M.), driving an air compressor for starting . . . in the service of the Panhandle Eastern Pipeline Co., Hugerton, Kansas.

Perhaps YOU have a power picture that requires thoroughly dependable, heavy-duty serviceability, too. Wisconsin Air-Cooled Engines stand on a record of seasoned performance, in a great diversity of applications in the oil field. Check with Harley Sales Company for details.

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World's Largest Builders of Heavy-Duty Air-Cooled Engines

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Oil field distributors for Wisconsin Engines and all types of utility units.

AT THE RIG...
with a SHAFFER PORTABLE PIPE STRAIGHTENER

Check over these heavy-duty, time-saving, work-saving features!

GET OUT your pencil and figure the multiple savings to be made by straightening your bent or kinked pipe *at the well* instead of trucking it into a shop to have the job done. The Shaffer Portable Pipe Straightener is a completely self-contained, heavy-duty unit that can be quickly hitched to a small pick-up and pulled to even the most remote well site. Here are some of the many advantages of taking the Straightener *to the pipe*, instead of trucking the pipe to the Straightener . . .

(Top) Shaffer Portable Straightener with side bracket opened for rolling pipe onto the machine.
(Lower) View of hydraulic operating device.

YOU SAVE LABOR The Shaffer Portable Straightener is completely power driven and very easy to operate. Simply roll the crooked pipe onto the Straightener, apply pressure with the power-driven ram to straighten the bent portions, and then roll the pipe back onto the rack. No specially-trained labor is needed!

YOU SAVE TRANSPORTATION Think how much simpler, quicker and less expensive it is to simply tow the Shaffer Portable Straightener out to the rig site with a light truck rather than tie up a heavy truck with the time necessary to load, transport and unload the pipe at the shop . . . and load, transport and unload the pipe back at the rig!

These are only a few of the many important savings the Shaffer Portable Pipe Straightener can make in your operations. This Straightener should be a part of every well-run field unit—even those located close to service shops . . . and is indispensable to wildcat operations.

YOU SAVE TIME With a Shaffer Portable Straightener you can roll pipe from the rack onto the Straightener, straighten it, and roll it back onto the rack ready for instant use in only a fraction of the time necessary *to just load it on the truck* and take it to a shop; let alone straightening time at the shop plus reloading and return trips!

Fully Power Driven:
The Shaffer Straightener is power-operated by a ¾ H.P. AC or DC reduction-gear motor. Or, the unit can be built with both AC and DC motors if desired to permit using either type of current for operation. Or the unit can even be operated by gasoline, gas or butane engines for those locations where neither AC nor DC current is available. It is adaptable to virtually any type of power!

Fool-proof Hydraulic Operation:
The acutal pressure that straightens the pipe is applied by an 8" hydraulic ram that is actuated by a double piston pump with ¾" pistons and 4" stroke operating at 125 rpm. Tremendous pressure is thus obtained for straightening even heavy-walled drill collars . . . *yet the pressure is under constant and sensitive control of the operator at all times!*

Oil is used for the fluid, thus eliminating corrosion and maintenance problems. There is no loss of fluid during operation.

Automatic Ram Return:
Ram operation is controlled by a convenient valve and when the pressure is released, heavy coil springs automatically return the ram to its initial position. No manual or time-wasting operations are necessary to retract the ram.

Rugged Non-Warping Frame:
The frame of the Shaffer Straightener consists of two 15"-50 lb. I-beams, each 15 feet long and held in accurate alignment by two trunnion posts. The frame maintains its accurate alignment under even the heaviest straightening loads.

Completely Unitized:
The motor, crankshaft, cross heads, ram and pump are all assembled between the two I-beams for maximum compactness and convenience in transporting and operation.

Side-Opening Bracket:
It is not necessary to feed pipe in through the end of the Straightener. One side of the Bracket can be quickly opened to permit rolling pipe directly onto the Straightener from the side.

Built-in Jacks:
Four quickly-adjustable jacks are built into the Straightener thus permitting fast leveling of the unit without need for wooden supports or other makeshift cribbing. Also note in the illustration the two portable roller stands furnished with the unit. Unique leg adjustments permit raising or lowering these stands so that the pipe can be kept level throughout its entire length to eliminate bending strains.

There are still other unique features incorporated in this unit. Write for full details!

The Shaffer Portable Straightener is a heavy-duty, ruggedly-engineered unit that will easily handle any size pipe, casing, tubing, drill pipe or drill collars up to 6" in diameter. Check over at right some of the unique features built into this Shaffer product . . . and then get in touch with your nearest Shaffer representative for complete details on the many vital savings it can make for you.

See Pages 2687 to 2730 of the Composite Catalog for helpful information on a wide range of Shaffer products and Shaffer equipment.

Send for the complete Shaffer catalog.

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HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

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(10) "Full liner" pump

Further rounding out its line of Oilmaster down well pumps, Fluid Packed Pump Company, Los Nietos, California, has recently placed on the market a Tubing "Full Liner" pump. According to the manufacturer, this precision built, economically priced pump was made possible by the company's advanced mass production heat treating and honing methods, which were developed for the manufacture of their improved insert and volume producer pumps.

The Oilmaster Tubing "Full Liner" pump is similar in construction to the coventional type, sectional liner tubing pump, the difference being in the substitution of a one piece alloy steel liner for the sections normally used in a tubing pump.

This modern compact unit eliminates needless bulk, reduces weight, and substantially decreases the number of parts required yet maintains a tensile strength sufficient to produce efficiently and economically from any reasonable depth, it is asserted.

The high tensile strength of the alloy steel liner has made it possible to reduce its wall thickness to less than half that of the cast liner section, which, in turn, permits the liner jacket to be reduced in size accordingly.

Full liner construction eliminates the hazard of misalignment and lends greatly to free plunger travel, it is stated. Special tools or aligning mandrels are not required to assemble or repair the Tubing "Full Liner" pump.

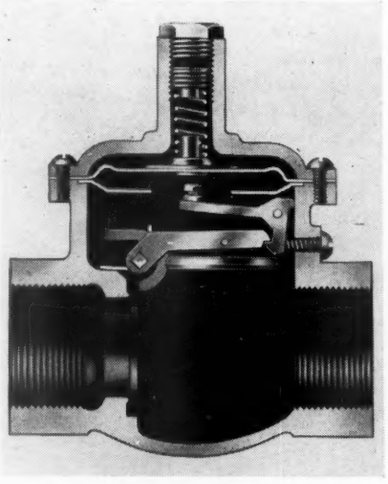
The Oilmaster Tubing "Full Liner" pump is made in two standard types, Type "P" and Type "F". Both types are of the same general design, the difference being in the plunger and parts accessory group. The two standard assemblies utilize the same basic barrel unit, which consists of two collars, a jacket, and the one-piece alloy steel liner. The liner is cased inside the jacket and is held in position by the collars.

(11) Warden valve

The new Warden Valve, manufactured by Security Valve Company, 410 San Fernando Road, Los Angeles, California, instantly shuts off the flow of any fluid when pressure drops below any predetermined level. This positive, automatic action protects against momentary pressure drops or ruptured pipe lines, to prevent fire, explosions, or other damage.

These valves are easily installed in gas or oil supply lines for industrial furnaces, institutional heating plants, public utility supply systems, or any other gas or oil user. Each valve is manually set to close at a specified pressure that can be varied for each installation. When the fluid flow drops below this pressure, the spring-operated diaphragm drops down and trips the valve-closing mechanism. The valve is manually reset by turning the valve control shaft in a counter-clockwise direction until it automatically latches in open position.

Warden valves are available from 1½ in. to 8 in. diam. They are all bronze, unless otherwise specified, with Neoprene diaphragm. The self-draining feature of the Warden design assures positive action even with heavy fuels, it is stated.



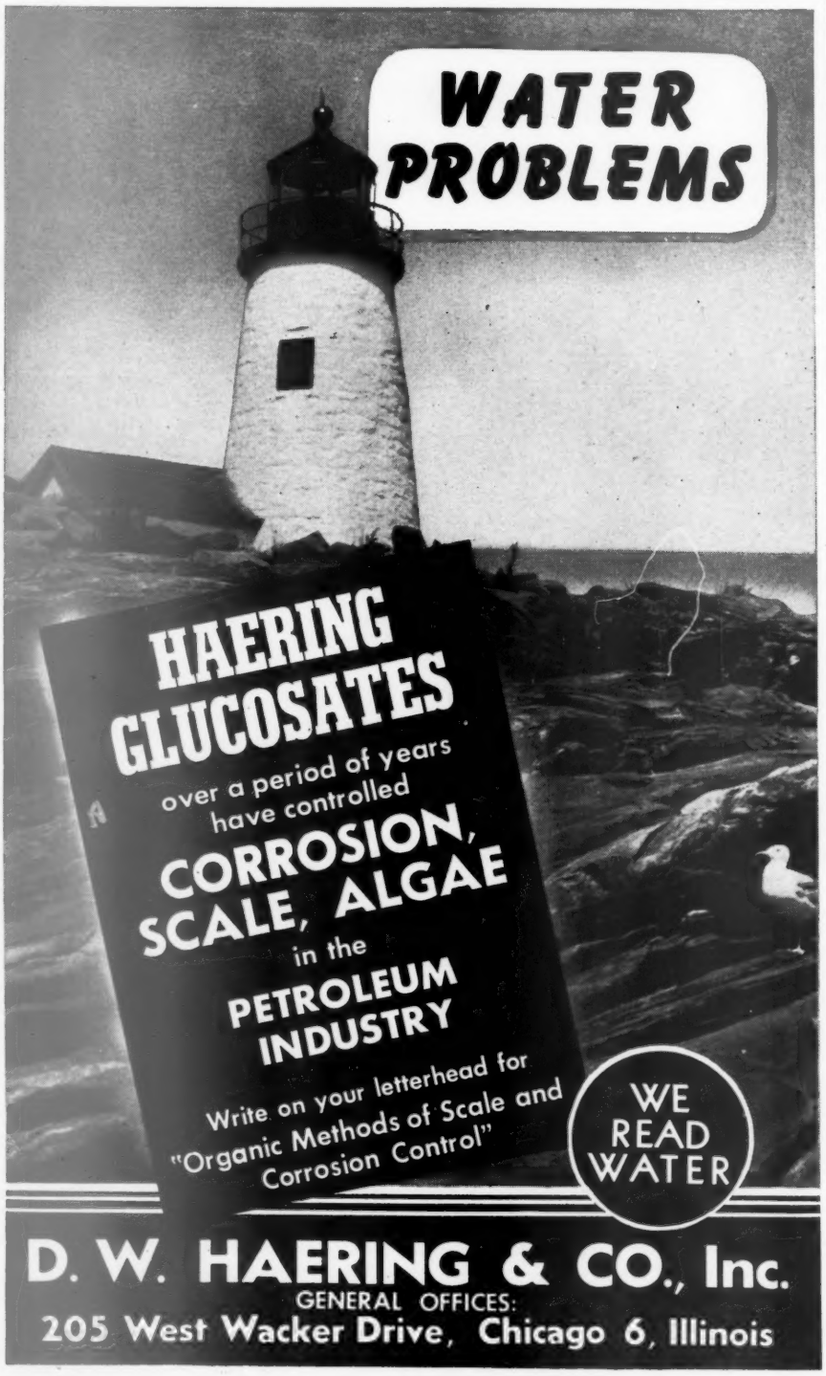
(12) Heavy duty machine

Marion Power Shovel Company, Marion, Ohio, announces a new 3½-4 cubic yard machine—the type 111-M—for heavy duty service in mining, quarrying, stripping, and general construction.

The 111-M fills a long-felt need for a diesel-powered machine in this size that can be readily shipped without major dismantling and which is also quickly convertible to dragline or clamshell service, the manufacturer states.

It is of all-welded construction with a balance in design providing for low center of gravity, making the machine stable under all digging conditions. Particular care has been given to the requirements in heavy duty service for speed, power, ease of control, and maneuverability.

Variable crawler widths and lengths are


WATER PROBLEMS
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over a period of years have controlled
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Write on your letterhead for "Organic Methods of Scale and Corrosion Control"
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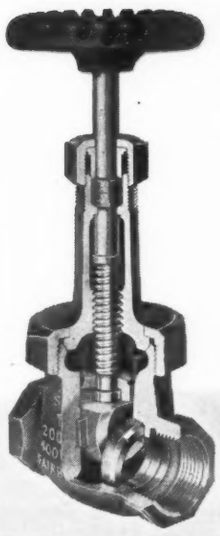
high-value highlights of the fairbanks bronze valve line



MANY VALVES FOR MANY SERVICES can be selected from the broad range of Fairbanks Bronze Valves highlighted here. Made for pressures from 125 to 300 pounds, Fairbanks Valves are available with screwed or flanged ends also with Faircoseal ends for Silbraz joints.

The Fairbanks distributor performs **many services for many industries.** Adequate stocks of all types of piping and mill supplies as well as Fairbanks Valves are available as needed, day or night.

Consult your distributor for all valve installation requirements.

Fig. 0236
200 Pound UNION BONNET BRONZE GATE VALVE
Rising stem — renewable nickel alloy seat and wedge.

The superior hardness and corrosion-resistance of nickel alloy wedge and seats, in addition to the sturdy hexagonal union nut, with radial body bonnet joint make this new valve particularly adapted to long, satisfactory service, with low maintenance cost. Also available in non-rising stem type and with integral seats.

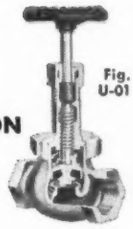


Fig. U-01

COMPOSITION DISC Globe and Angle

Union bonnet — integral seats — 150 and 200 pound pressures. For services requiring quick disc renewal

Fig. 033

REGRINDING Globe, Angle and Cross

Bronze disc—integral seat—union bonnet—200 and 300 pound pressures. For higher pressure service where composition discs are not satisfactory.

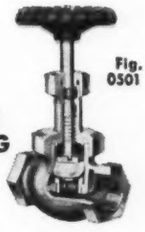


Fig. 0501

RENEWABLE REGRINDING Globe and Angle

Nickel alloy seat and disc—union bonnet—200 and 300 pound pressures. For more severe services on steam, water, oil, gas and air.

Fig. 0501-P

PLUG DISC AND SEAT Globe and Angle

Renewable hardened nickel alloy seat and disc—200 pound pressure. For throttling and other service requiring close regulation of flow.

Fig. 0250

NON-RISING STEM Gate Valves

Screwed bonnet — solid wedge — taper seat 125, 150 and 300 pound pressures. For full flow of steam, water, oil and gas.

Fig. 0228

RISING STEM Gate Valves

Screwed bonnet — split wedge — solid wedge for 125 and 150 pound pressures. For steam, water, oil and gas.

Fig. 0209

OUTSIDE SCREW AND YOKE Gate Valves

Screwed bonnet — solid wedge — taper seat — 150 and 300 pound pressures, where operating threads must not contact fluids.

Fig. 0230

UNION BONNET Gate Valve

Non-rising stem — nickel alloy wedge—integral seat—200 pound pressure. For higher pressures on steam, water, oil and gas.

Fig. 0601

SWING CHECK VALVES

Horizontal—renewable bronze disc—125, 150, 200 and 300 pound pressures. For maximum flow of steam, water, oil and gas.

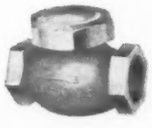


Fig. 0616

LIFT CHECK VALVES

Horizontal—angle. Renewable composition disc for 150 pounds —regrinding bronze disc for 200 and 300 pounds. To prevent return flow. Positive vertical lift of discs.

American industry flows through fairbanks valves

Write for further information on the types of valves required or ask for Catalog "42". The Fairbanks Company, 393 Lafayette Street, New York 3, N. Y., also Boston 10, Mass., Houston 2, Texas, and Pittsburgh 22, Pa.

offered, making the machine adaptable to individual job requirements.

The upper machinery deck follows Marion's proved design and its simplicity and accessibility are particularly notable. There are only two main shafts, mounted in anti-friction bearings, on the upper deck, providing direct line of power application, thereby simplifying maintenance and assuring added long life for the machine.

Marion air control, proved in service under all types of climatic conditions, provides for the operator a new conception of control for all operations.

The Type 111-M is quickly convertible to dragline, clamshell, or crane service.

The 111-M is built to provide ample strength for the heaviest digging service, to ship assembled with a minimum of dismantling, to be readily convertible from one type front end to another. Anti-friction bearings for all high speed shafts and unit construction assure long life and low maintenance expense, it is stated.

The Type 111-M diesel power plant, in combination with Marion air control with fully-compensating type valves, places heavy-duty power at the disposal of the operator with a minimum of tiring physical exertion on his part. Control lever pressure is held to approximately 12 lb. maximum. The fully-compensating type valves give the operator the constant "feel" of the load and enable him to apply or withdraw power gradually or quickly.

The shovel boom is of all-welded, full box section construction with rounded edges for added strength, and has a wide spread base. Boom point sheaves are extra large and sheave bearings are unusually wide. Shipper shaft pinions are double shrouded. Dipper handle members are of all-welded construction with welded racking, and the handle is connected to the dipper by wide bearing bosses.

The gantry, designed for quick knock-down for rail shipment, can be lowered to cab roof level by paying out on the boom hoist line.

For crane or pile driver service, the Type 111-M is equipped with a heavy duty box section type boom with steel angles and pipe-section bracing. The boom point section is of goose-neck design which permits minimum radius operation.

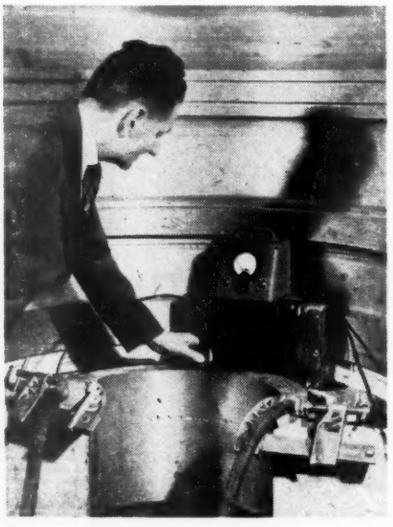
An independent live boom hoist may be supplied with the Type 111-M for crane service. It is completely independent of all other motions.

(13) *Magnetic-field gage*

A new magnetic-field gage that indicates the relative strength of the magnetic field in parts that are being examined for flaws by the magnetic-particle method of testing has been announced by the General Electric Company. The new instrument is especially useful for testing large castings and forgings in which it is difficult to calculate the field intensity at various points from the current passed through the part and the cross-sectional areas.

In testing parts for flaws with the magnetic-particle method, a magnetic field is first set up in the part. Then magnetic particles are distributed over the surface of the part, and these line up along any crack or flaw. However, it is possible for a defect to be present even though not indicated by the magnetic particles if the magnetic field is not strong enough to bring out the particle pattern, and often identical flaws will appear as different sizes and thus give inconsistent results. The new magnetic-field gage assures a magnetic field that is sufficiently strong to bring out the particle pattern, so that defects of the same size give similar indications. By giving a direct indication of field strength, it permits standardized testing at fixed field intensities.

The new instrument measures both alternating-current and direct-current field strength. Small and portable, it can be used wherever 115-volt, 60-cycle power is available. The instrument consists of a gage head that is permanently attached to a field



For almost every *heavy duty* application where the load is radial, there is an adaptable, durable, dependable AMERICAN RADIAL ROLLER BEARING capable of withstanding the tremendous stresses and strains demanded by the ponderous equipment and stepped-up tempo of today's manufacturing. And because they are *specially* designed for "tough going," AMERICANS render smooth, continuous, trouble-free service under the most adverse operating conditions, resulting in lower maintenance costs and increased performance-life of heavy machinery and equipment.

AMERICAN RADIAL ROLLER BEARINGS are made in 5 styles, 4 S.A.E. series and 85 sizes. Special designs to order are also available. Consult our engineering department on all your roller bearing problems. Write today!

AMERICAN ROLLER BEARING CO., Pittsburgh, Pa.

Pacific Coast Office: **1718 S. Flower St., Los Angeles, Calif.**

AMERICAN ROLLER BEARINGS HEAVY DUTY

AMERICAN

Heavy-Duty ROLLER BEARINGS

Watch Out for the BRIGHT ONES!

Only one of these joints is normal. It is rubbered with a Patterson-Ballagh Protector and does not shine! The bright ones have a polish —attractive to the eye but dangerous to successful drilling. They got their shine rubbing against precious casing and grinding it thin. Watch out for these bright ones!

A well known Mid-Continent drilling contractor was drilling below 10,500 feet with 10¾" casing set. Since the pipe had no Protectors and the Kelly sub had no Stabilizer, they shook loose the two top joints of casing. After fishing several days to find the top casing they removed the loose joints from the hole. The operator finally ran a packing casing bowl in order to repair his string of casing. This cost him many days' delay and approximately $20,000. He has since installed a Patterson-Ballagh Drill Pipe and Casing Protector on every joint and a Stabilizer on his Kelly sub to get 100% protection against this danger. This put an end to his casing trouble.

MORAL: Bright joints today may mean dull drilling tomorrow. Ask your Patterson-Ballagh man for a Protector on *every joint.* Drill with the confidence 100% Protection gives you.

Specify **PATTERSON-BALLAGH**

A DIVISION OF BYRON JACKSON CO.

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DRILL PIPE & CASING PROTECTORS

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strength indicating unit. The head consists of small coils wound around a U-shaped laminated metal core mounted in a plastic handle. Pole shoes are attached to the ends of the core, and these make contact with the piece being tested.

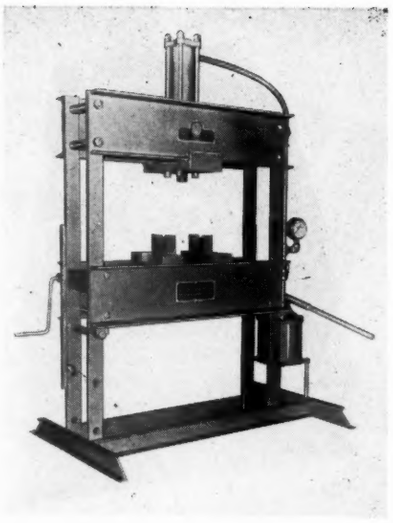
On the front of the indicating unit are mounted an indicating instrument with two scales, two selector switches for alternating or direct current, and an on-off switch. The instrument scale is calibrated in field units that are related to the magnetic-field strength.

In operation, the pole shoes are placed in contact with the test surface. Direct or alternating current is then applied to the part in accordance with the regular magnetic-particle method. The current is increased or decreased until the magnetic-field gage indicates the desired field units for the particular test. The magnetic particles are then applied in the specified way.

(14) *60-ton shop press*

A new shop press of 60 tons capacity is announced by Rodgers Hydraulic Inc., Minneapolis, Minnesota, makers of hydraulic presses of many types. Features of the press, called the Rodgers "Sixty," are fast operation, ruggedness, versatility, and large capacity for work size.

Power is supplied by a Rodgers 2-speed hydraulic hand pump that, in high speed, moves the ram 2½ in. per pump stroke, giving up to 2000-lb. pressure in fast travel.



Lever on the pump may be quickly flipped for high pressure operation.

The hydraulic cylinder rests on rollers that ride the flanges of the upper bolster, and may be moved across the entire working width of the press when desired. Ram travel is a full 13 in. at a continuous stroke, due to the long cylinder.

Flexibility of the press is achieved through adjusting the lower bolster by means of a hand crank. Maximum opening between bolsters is 38 in., minimum is 8 in. A special model with an opening range from 8 in. to 48 in. is available. Although working width between the sides is a generous 45 in., long pieces may be handled through the open sides any place above the globe valve and pump.

The hydraulic pump, globe valve, and gauge in tons and pounds are situated on the lower right side of the press for operating convenience.

A machined and matched pair of V-blocks is supplied as standard equipment. Special attachments for ring gear riveting and for aligning and centering shafts, rod, etc., are available, as well as an end support stand (adjustable) for handling long material.

It is said that a great variety of general shop operations are easily performed by the Rodgers "Sixty," such as: pressing, straightening, shearing, bending, clamping, riveting, broaching, and assembly work.

(15) *Oil choke*

PermaFlo Choke (or flow bean) developed by Schick-Siegal Industries of Los Angeles, California, is the first oil choke that will not "cut-out," according to the manufacturer. Essentially planned for "hard to hold" wells with fast high pressure "cut-outs," this flow bean has been manufactured from the finest of materials in order to resist wear from abrasion such as sand flowing at high pressure. A bronze sleeve is used with a platinum gold thermide seal and the liner is of wear resistant porcelain.

During the last two years remarkable records have been set up in tests in the Corpus Christi area. Here are some of the worst known "sanding" conditions—flow pressures of more than 1600 lb.; and after 18 months of constant operation, one well reports less than 0.001 per cent of wear, for a normal well. In the most difficult wells, field men reported "cutting out" notice in excess of 10 hr. with no damage, enabling them to substitute a new choke without loss. PermaFlo was developed while tool design experts

SPECIFY
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SPANG TUBING SPEAR
(Fig. F533)
SPANG TRAP SOCKET
(Fig. F538)
Fig. F533
Fig. F538
FOR FISHING TUBING Spang offers a variety of tools, including Combination-Type Tubing Socket, Slip-Type Tubing Socket with mandrel, Cherry Picker, Spang Alligator-Style Grab, Tubing Spears in a variety of types, and the Spang Trap Slip Socket (Ill.) which has a unique slip arrangement enabling it to catch tubing or slivers in almost any condition.
For the best in Cable Tools,
SPECIFY SPANG
THE HIGHER STANDARD
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YOUR DEALER SELLS SPANG TOOLS

THE NEW OTIS TUBING CALIPER MEASURES THE MAXIMUM DEPTH AND LOCATION OF CORROSION PITS AND INDICATES MINIMUM TUBING WALL THICKNESS

Tubing corrosion surveys, through use of the new OTIS TUBING CALIPER, have been completed on 10,000 feet of tubing in a single day. Photostats of the caliper logs are delivered to the operator with a comprehensive report on each well. Thus, the condition of the entire tubing string can be quickly analyzed, or each joint studied individually. Otis Pressure Control crews, consisting of an engineer, and a wire line specialist experienced in years of installing and maintaining sub-surface controls, are running the OTIS TUBING CALIPER. An illustrated pamphlet will be mailed on request.

OTIS

T. M. REG.

OTIS PRESSURE CONTROL, INC.

TUBING CALIPER

FIELD OFFICES: TEXAS: HOUSTON, CORPUS CHRISTI, and LONGVIEW OKLAHOMA: OKLAHOMA CITY. NEW MEXICO: HOBBS. LOUISIANA: NEW IBERIA

OTIS ENGINEERING CORPORATION—MANUFACTURE AND DEVELOPMENT

DISTRIBUTORS: OTIS PRESSURE CONTROL, INC., DALLAS, TEX.; OTIS EASTERN SERVICE, INC., BRADFORD, PA., WESTERN PRESSURE CONTROL, LOS ANGELES, CALIF.

were attempting to line high production shell draw dies with carbide, to resist wear in quantity runs in the millions, when the "lining" material was developed that is used in PermaFlo. Tooled-up for high production, the choke price will be comparable with prewar steel types due to standardization on sizes. Adapter bushings for all sizes are available.

(16) *All-metal wing*

Introduction of a simply designed all-metal wing that makes the Silvaire the only completely all-metal light plane in volume production in the world has been announced by L. H. P. Klotz, president of Luscombe Airplane Corporation, Dallas, Texas.

The new wing, approved by the government and already in production, consists of a metal shell structure built around two metal spars and two ribs. It is probably the greatest single postwar development in light-plane design, Klotz pointed out.

This postwar trend toward all-metal planes in the low-priced field will undoubtedly be followed in the near future by most light plane manufacturers, he predicted, observing that Luscombe is a pioneer in light plane all-metal structures, having been in this field for more than 12 years.

The new stressed-skin wing design results in a five to eight mile an hour increase in speed over the standard 65-hp. model now being manufactured at the rate of more than 12 planes per day, Klotz said.

Patents are pending on the new design.

The all-metal wing also incorporates a single, strong, non-welded strut between the wing and the fuselage in place of the previous V-strut and jury struts used on Luscombe planes. The new single strut provides easier access to the cabin of the plane and provides added visibility for both pilot and passenger.

The general physical appearance of the wing gives a pleasing, unbroken expanse of gleaming metal. Corrugation is employed on the trailing edge to match the ailerons.

Due to the absence of internal structure, periodic inspection can be conducted almost entirely externally as only two inspection openings per wing are required on the metal wing—aileron pulley brackets and wing tank gasoline connection—as compared to 13 on each wing in the fabric wing.

The extremely simple design of the metal wing results in ease of production as well as greatly reduced repair costs. The wing is composed of nine panels, all of which are replaceable. The lifetime, all-metal construction also eliminates the several hundred dollars required every year or so to recover wings employing fabric covering. Badly damaged sections may be repaired with facility without replacing the entire wing.

The great durability of the metal skin means that the wing will withstand ice, snow, hail, and the fabric rot common in the tropics.

(17) *Sealing compound*

Rector Well Equipment Company, Inc., Fort Worth, Texas, announces that Rector-Seal No. 15 is now available commercially as a thread lubricant and seal on oxygen lines and fittings. Developed during the war, this compound was used on lines carrying breathing oxygen in combat aircraft. Because it does not react with oxygen, it overcomes the former hazard of using lubricant on oxygen lines, and makes possible a safe, leakproof screwed connection that can be changed readily without damage to threads or fittings. It is used also as a stem lubricant on oxygen valves. The compound is supplied in paste form and packaged in 1, 5, and 10 lb. cans. Immediate shipment can be made from the company's Houston plant. Data sheet giving detailed physical characteristics is available.

(18) *Buda jacks*

The Buda Company, Harvey, Illinois, announces the addition of 50-ton Hydraulic Journal Jacks to its line of jacks.

Buda's two-speed hydraulic jacks have two distinct speeds, a fast speed for quickly raising light or medium-heavy loads; normal or standard speed for raising capacity loads. The raising of loads is by easy pumping action. Lowering of loads is regulated by a simple control valve, making the loads under complete control of the operator. Loads may be held indefinitely at any height.

Buda Models 50-B-2 and 50-B-26 hydraulic jacks are 50-ton jacks designed especially for general high lifting jobs. They are used a great deal in railroad repair shops, for bridge work, and for extremely heavy general industrial lifting. Model 50-B-12 has a height closed of 12 in., a rise of 7 in. and weight of 120 lb.; Model 50-B-26 has a height closed of 26 in., a rise of 20 in., and a weight of 200 lb.

(19) *Throat chasers*

The Landis Machine Company, Waynesboro, Pennsylvania, announces a Centering Throat Chaser for work that must have threads concentric with the outside diameter. It is especially adapted to the threading of valve stems and other long length threads of coarse pitches.

This chaser can be used only when the outside diameter of the work is held uniform. The outside diameter of the work must be uniform since the centering throat section of the chaser takes a bearing on the O.D. The chasers are flexible in that any differece on the O.D. can be corrected on the centering throat to maintain proper pitch diameter.

For example, if the outside diameter is 0.625 and the pitch diameter 0.005 under basic, the centering throat section of the chaser can be ground 0.0025 below the root of the thread to compensate for the difference.

In addition to holding concentricity between the thread and outside diameter of the work, the Centering Throat Chaser eliminates an out of round condition that often exists when long work pieces are threaded, making it necessary to extend the work out from the carriage front or chuck for a considerable distance. The centering throat takes a bearing as soon as the chaser contacts the work and assures accurate and well formed threads from the start.

Work pieces on which long, coarse threads must be produced should have sufficient relief at the end of the thread to permit the use of Landis Centering Throat Chasers. They can be supplied for use in all Landis Thread Cutting Die Heads.

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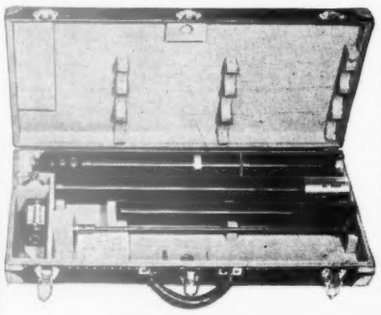
POST WAR MODEL

Multiple Shot OIL WELL SURVEY INSTRUMENT



Makes a continuous record in one run of the direction of the hole and its deviation from the vertical. The complete survey is plotted in our offices and a finished copy supplied to the customer. For accurate, dependable surveys, call the *Pioneers* of oil well survey service.

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Close-up of the type of Nugent lube oil filter used on Ingersoll-Rand compressor units.

Compressor Efficiency INCREASED with NUGENT FILTERS

Helping Ingersoll-Rand protect its famed reputation for compressor efficiency, low maintenance and long life are Nugent Filters, used to filter lube oil for compressor units, as well as fuel and lube oil on Diesel power units. By depending on the proved design and dirt removing ability of Nugent Filters, I-R compressor crankcases can remain sealed, completely protected against damage from foreign particles. Diesel engines used for powering these compressors are doubly protected by Nugent Filters, as both fuel and lube oil are kept practically 100% clean all the time. Let Nugent engineers help solve your filtration problems.

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TRADE LITERATURE

Publications listed are sent free upon request.

(20) *Lubricated plug valves*

American Car and Foundry Company, New York, has issued a revised 8-page pamphlet on ACF full pipe area lubricated plug valves. The valves are used in services involving acids, caustics, chemicals, oil, water and other fluids, air, gas, and vacuum.

(21) *Casing centralizer*

The Baker casing centralizer is the subject of a bulletin issued by Baker Oil Tools, Inc., Los Angeles, California. The vital importance of centralized casing in obtaining a good "first time" cement job is pointed out.

(22) *Selenium rectifiers*

Information on Selenium rectifiers is given in a bulletin published by the Federal Telephone and Radio Corporation, Newark, New Jersey. The rectifier equipment shown in its pages is indicative of the types of equipment offered for d-c. requirements. All equipment shown is powered by Selenium rectifiers, which the manufacturer states provide the utmost in reliability, efficiency, and long life.

(23) *Sucker rods and couplings*

Factual data on sucker rods and sucker rod couplings manufactured by the D + B Division of Emsco Derrick and Equipment Company, Los Angeles and Dallas, are given in a bulletin recently released.

(24) *Safety control*

Data sheet W-1, issued by Viking Instruments, Inc., Stamford, Connecticut, describes the Viking safety control, an alarm system for trucks and boats. The control provides a visual and audible signal in case of insufficient engine lubricating oil pressure or excessive engine cooling water discharge temperature.

(25) *Bulge type portable masts*

Emsco Derrick and Eqquipment Company, Los Angeles, California, has issued a new comprehensive bulletin covering the Emsco bulge type portable drilling masts. The bulletin explains in detail the erection procedure, various safety features and operational data of this late-type mast.

(26) *Boiler water conditioning*

A booklet, "The Six Fundamentals of Betz Water Conditioning Service," illustrates and describes how W. H. and L. D. Betz extends a supervisory service for boiler water conditioning. It outlines, step by step, the procedure that leads to trouble-free boiler plant operation.

(27) *Centrifugal pumps*

The Carver Pump Company of Muscatine, Iowa, has issued an 8-page bulletin describing a new line of centrifugal pumps ranging in capacity from 40 to 900 gal. per min. and heads up to 200 ft. or higher. Included in the bulletin are details of the hydraulic design that the manufacturer says results in higher pumping efficiency for all classes of general service—efficiencies well in excess of 80 per cent for pumps as small as 2½ in. Electropumps are available with a choice of enclosures for hazardous locations.

(28) *National Supply tubinghead*

Six detailed cutaway drawings of typical applications of The National Supply Company's type "W" tubinghead feature Bulletin 327 just published by the company. The type "W" is an extremely flexible unit designed to support a string of tubing and to seal that string from the casing. It is available for working pressures from 1000 through 3000 lb. per sq. in. Through the use of adapter flanges it can be used with type "B" wellhead equipment. The bulletin also carries two photographs and technical data on the tubinghead bodies and adapter flanges.

(29) *Hydraulic systems*

Hydraulic systems, operating at 1200 and 800 lb. per sq. in., present some unusually troublesome and costly problems. Cracking of soluble oil solutions, cooling chambers completely closed with scale deposits, general corrosion, excessive "down" time, and high "outage" of expensive parts introduce complications that tested the efficiency of the Glucosates. An interesting discussion of the solution of these problems is found in the current issue of H-O-H Lighthouse, published by D. W. Haering and Company, Inc., Chicago, Illinois.

(30) *Correlation chart*

A large sized data sheet, folding into an 8¼-in. by 11-in. cover, lists every well known stainless steel by trade name with the proper Arcos alloy electrode for welding each. AISI type numbers and analyses of the trade named stainless steels are given, as well as the weld metal chemical analysis of the corresponding Arcos electrodes. This correlation chart has been prepared by Arcos Corporation, Philadelphia, Pennsylvania.

(31) *Properties of ketones*

A new booklet discusses the physical and chemical properties of ten commercially important ketones produced by Carbide and Carbon Chemicals Corporation, New York, New York. Specifications and shipping data are given in this booklet, as well as information regarding principal uses for these products. Ketones are important intermediates in the synthesis of industrial chemicals, and possess a high solvency for nitrocellulose and "Vinylite" resins. They are also widely used in the extraction of drugs, stripping of dyestuffs from textiles, coagulation of rubber latex, and dewaxing of lubricating oils.

(32) *Flow rate meter*

A small size low cost Rotameter has been developed specifically for purge line (Bubbler) service. A die cast unit so small it fits into the palm of the hand, this meter gives accurate, precise flow rate measurement with minimum space requirement and can easily be mounted in multiple on a panel, according to the manufacturer, Fischer and Porter Company, Hatboro, Pennsylvania. It can be supplied with or without an integral needle valve.

(33) *Electrical booklet*

Electrical equipment for every phase of the petroleum industry—drilling, pumping, transportation, refining, and marketing—is described in a new booklet announced by the Westinghouse Electric Corporation. The new 36-page booklet includes photographs showing installation and application of a-c. and d-c. drilling equipment.

(34) *Booklet on weldments*

"Weldments" is the title of a new bulletin issued by the Weldry Division of Graver Tank and Manufacturing Company, Inc., Chicago, Illinois. Attractive and fully illustrated, this 19-page booklet presents a comprehensive discussion of weldments as a modern metal fabrication method. Interesting and informative, the bulletin covers the many advantages of weldments, their flexibility, requirements, and comparative cost, along with a resumé of a weldry's function. Numerous photographs present an impressive picture of the wide range of metal parts and products that are efficiently and economically fabricated by welding.

(35) *Cummins general catalog*

The Cummins Engine Company, Inc., Columbus, Indiana, has brought out a new, 64-page general catalog of its products. Printed in four colors, this pocket-sized catalog gives detailed descriptions of five series of Cummins Diesel engines—Series H, Series HS, Series NH, Series NHS, and Series L. In each series, except the Series L, Cummins manufactures a wide range of models specifically designed for automotive, industrial, or marine use. The Series L Diesel is designed for industrial and marine use only. The five series of Cummins engines cover the power range from 84 to 275 hp.

(36) *Gas-lift catalog*

McEvoy Company, Houston, Texas, has issued a new catalog on gas lift. In addition to an unusually complete illustrated description of the McEvoy self-operating gas lift, this catalog presents data, formulae, and charts useful to all gas lift men. The section on the McEvoy gas lift valve describes, with the aid of two-color schematic drawings, the operating principle of this unusual valve. Cutaway drawings show important features of the valve's construction, and a parts list simplifies ordering of replacement parts. The technical data section includes a formula for spacing gas lift valves. It also includes many useful tables and graphs for figuring gas flow and choke diameters.

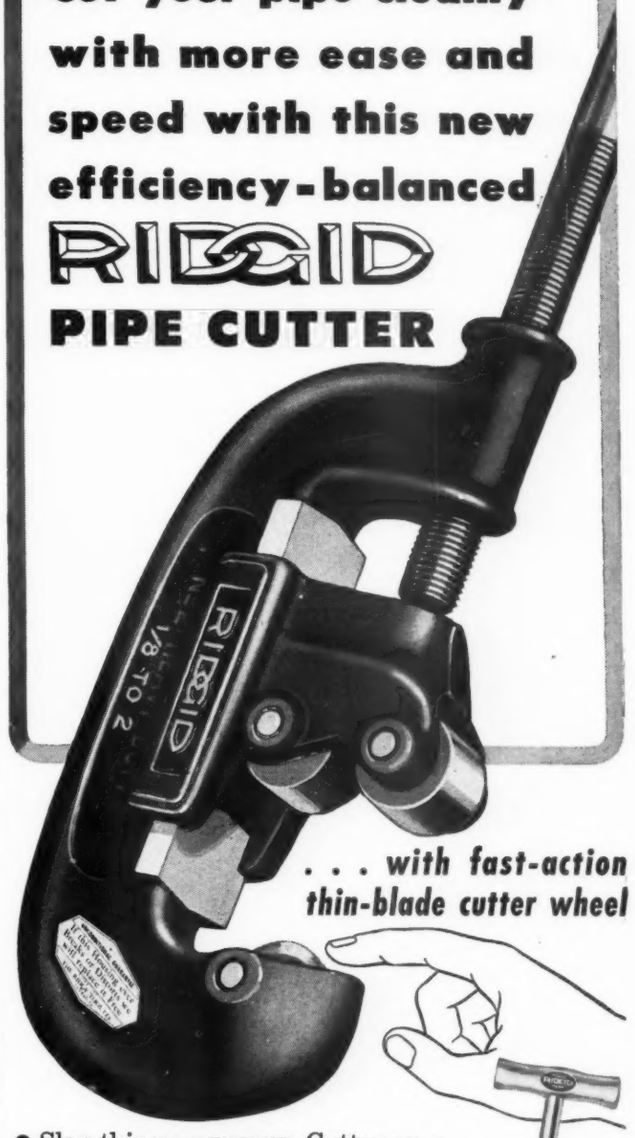
(37) *"GMX" compressor bulletin*

A 20-page well-illustrated bulletin describing the Cooper-Bessemer "GMX" compressor units has been compiled by the company. The booklet describes in detail the various exclusive design advancements of the "GMX," a gas-engine driven compressor unit that is available in 4, 6, 8, and 10-cylinder sizes, with a rating of 62½ hp. per cylinder at 500 r.p.m., for power requirements ranging from 250 to 625 hp.

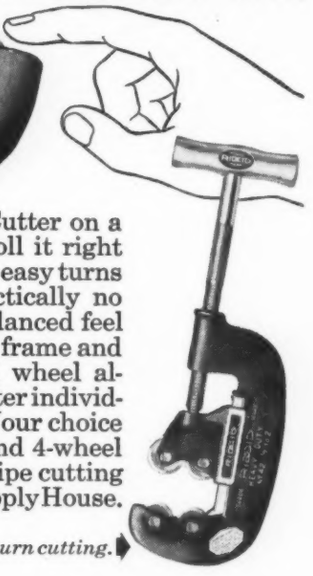
(38) *Rotary positive blowers*

Roots-Connersville Blower Corporation, Connersville, Indiana, has issued Bulletin 22;23-B-12 covering Rotary Positive Blowers. Roots-Connersville Rotary Positive Blowers are built in a wide range of sizes, from 5 to 50,000 CFM, at pressures up to 30 lb., and for vacuums up to 28 in. Hg. In addition to numerous installation illustrations, there are characteristic curves, cross-sections, and exploded views to show the operating principle and construction features.

Cut your pipe cleanly with more ease and speed with this new efficiency-balanced RIDGID PIPE CUTTER



. . . with fast-action thin-blade cutter wheel



● Slap this new RIDGID Cutter on a pipe, turn it tight and roll it right through your pipe in a few easy turns — thin wheel leaves practically no burr. You like the well-balanced feel of its new style malleable frame and the thin blade tool-steel wheel always cuts true—every cutter individually tested to assure it. Your choice of 5 sizes to 6" capacity and 4-wheel cutters to 4." For easier pipe cutting order RIDGIDs, at your Supply House.

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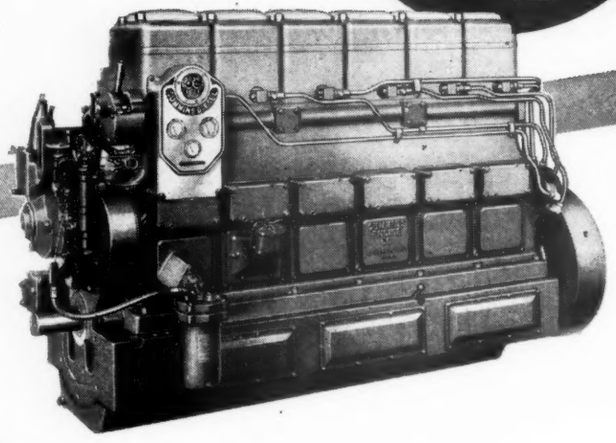

CUMMINS ENGINE COMPANY, INC., COLUMBUS, INDIANA

THE *Petroleum* Engineer's CONTINUOUS TABLES

A DAILY REFERENCE FOR OPERATING MEN

INSTALLMENT No. 109

A VALUABLE and regular feature of *The Petroleum Engineer,* the Continuous Tables, now in their tenth year of publication, were designed to save time and effort for the technician and the practical field or plant worker. The tables have proved one of the most popular and helpful departments of *The Petroleum Engineer.* Data are presented in the simplest form available with many types of information included that are best presented by curves or nomographs when three or more variables must be considered simultaneously.

The Continuous Tables have developed as a result of suggestions for new tables, direct contributions, and improvements to existing tables by members of the petroleum and related industries, including manufacturing concerns, who are continually searching for practical information reduced by computation to tabular form readily applicable to the problems daily confronting them that might otherwise necessitate a more or less tedious calculation. These contributions and suggestions from the industry have resulted in a valuable exchange of information and data contributing to the progress of the industry as a whole.

This index will be revised monthly. The index for installments 1-12, inclusive, will be found in the May, 1938, issue; 13-24, inclusive, in the June, 1939, issue; 25-36, inclusive, in the June, 1940, issue; 37-48, inclusive, in the June, 1941, issue; 48-60, inclusive, in the June, 1942, issue; 61-72, inclusive, in the June, 1943, issue; 73-79, inclusive, in the January, 1944, issue; 80-82, inclusive, in the April, 1944, issue; 83-85, inclusive, in the July, 1944, issue; 86-88, inclusive, in the October, 1944, issue; 89-91, inclusive, in the January, 1945, issue; 92-94, inclusive, in the April, 1945, issue; 95-97, inclusive, in the July, 1945, issue; 98-100, inclusive in the October, 1945, issue; 101-103, inclusive, in the January, 1946, issue, and 104-106, inclusive, in the April, 1946, issue.

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Gray Rotary Swivels are precision tools, manufactured to close tolerances, and are designed to give long, trouble-free service. The Gray balanced design and thorough utilization of proper materials make possible more strength with less weight in these swivels. Among the many points of excellence of Gray Rotary Swivels are forged heat-treated steel suspension members, load carried from the bottom, true Apex Main Bearing for easy rotation at all speeds and loads, lubricated wash pipe packing unit and lubricated bail bolt pins, stem mounted with three Roller Bearings to assure perfect alignment, oil reservoir to maintain proper lubrication for Upper Bearing, and bearings and mountings made especially for high rotating speeds. You'll get more revolutions with less wear, low maintenance cost, when you use Gray Rotary Swivels.

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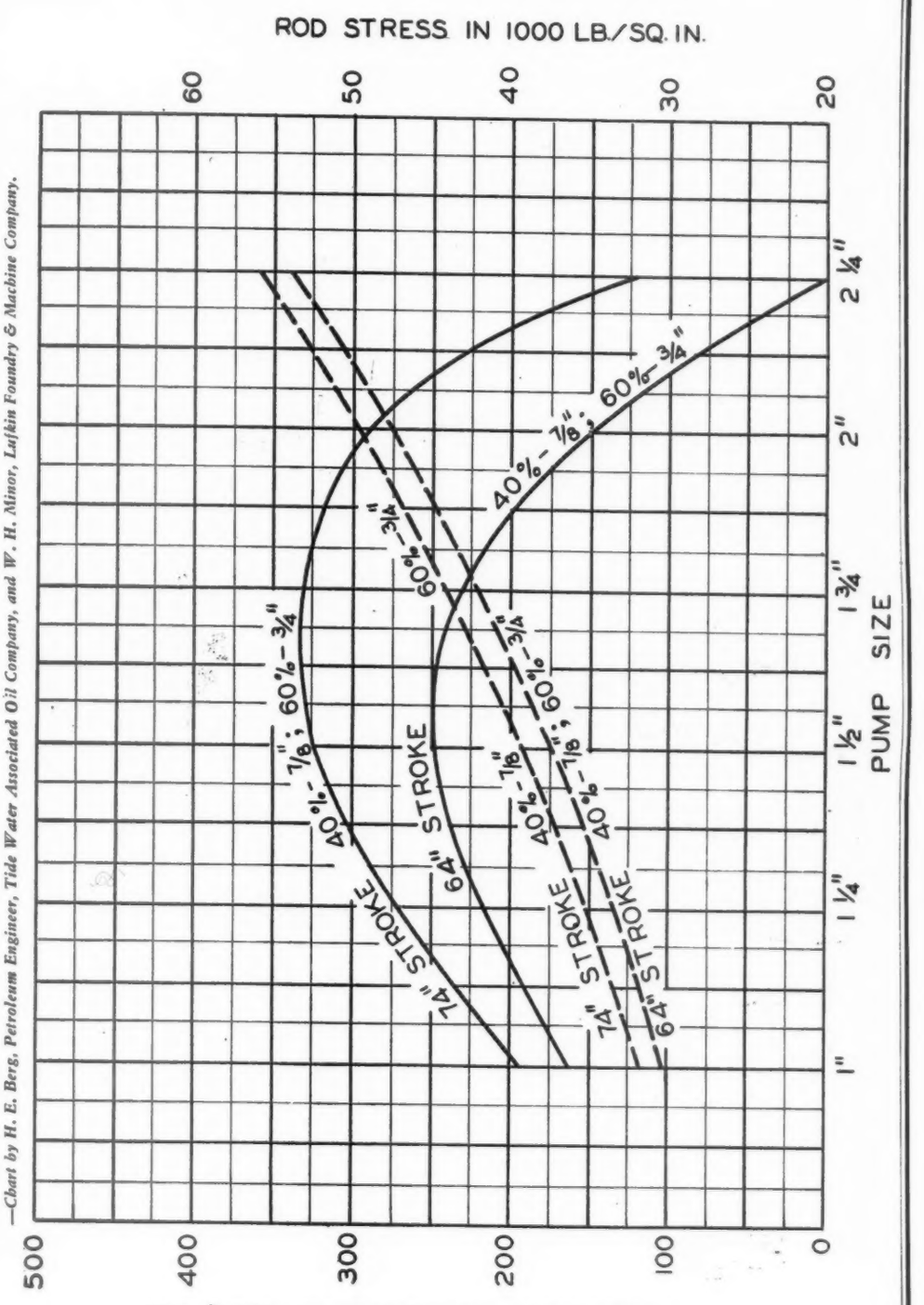
PLUNGER AND ROD SIZE SELECTION CHARTS FOR DEEP WELLS

This series of plunger and rod size selection charts have been designed to illustrate roughly the load and plunger travel conditions, peak torque and approximate horsepower requirements that should be anticipated in pumping deep wells. Mills' formula was used in calculating the polished rod load, and Sloneger's formula was used in calculating the peak torque. The production of the pumps has been corrected for sucker rod stretch, but not for volumetric efficiency. The specific gravity of the fluid pumped is assumed to be 1.00. The "allowable stress" is necessarily an arbitrary endurance limit, and, if exceeded, an unduly high number of rod failures may be anticipated.

The curves below show a comparison between 64-in. and 74-in. stroke pumping operations. The solid line curves represent the production, and the dashed line curves represent the stress for the combination rod string shown.

Conditions for Curve No. 10 (below):
Pumping depth, 7000 ft.
Strokes per min., 20.
Length of stroke, 64 in. and 74 in.
Size of tubing, 2½ in.
Peak polished rod load = 0.6 × rod stress shown.



—Chart by H. E. Berg, Petroleum Engineer, Tide Water Associated Oil Company, and W. H. Minor, Lufkin Foundry & Machine Company.

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DID YOU KNOW that the preforming process stepped up wire rope quality all along the line? To make preformed rope the manufacturer has to hold to close tolerances, exercise precise controls. That fine precision has made *all* wire rope, preformed or non-preformed, better than it was prior to the advent of preforming. Hazard has had long experience in these exacting methods. That is why Hazard LAY-SET Preformed, as well as Hazard non-preformed ropes, is uniform—reel after reel. Buy Hazard, and you get uniform quality—now and always. Buy Hazard LAY-SET Preformed Wire Rope made of Improved Plow Steel.

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TRADE MARK

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PUMPING UNIT CALCULATIONS CHART

SAMPLE CALCULATION—*Given:*

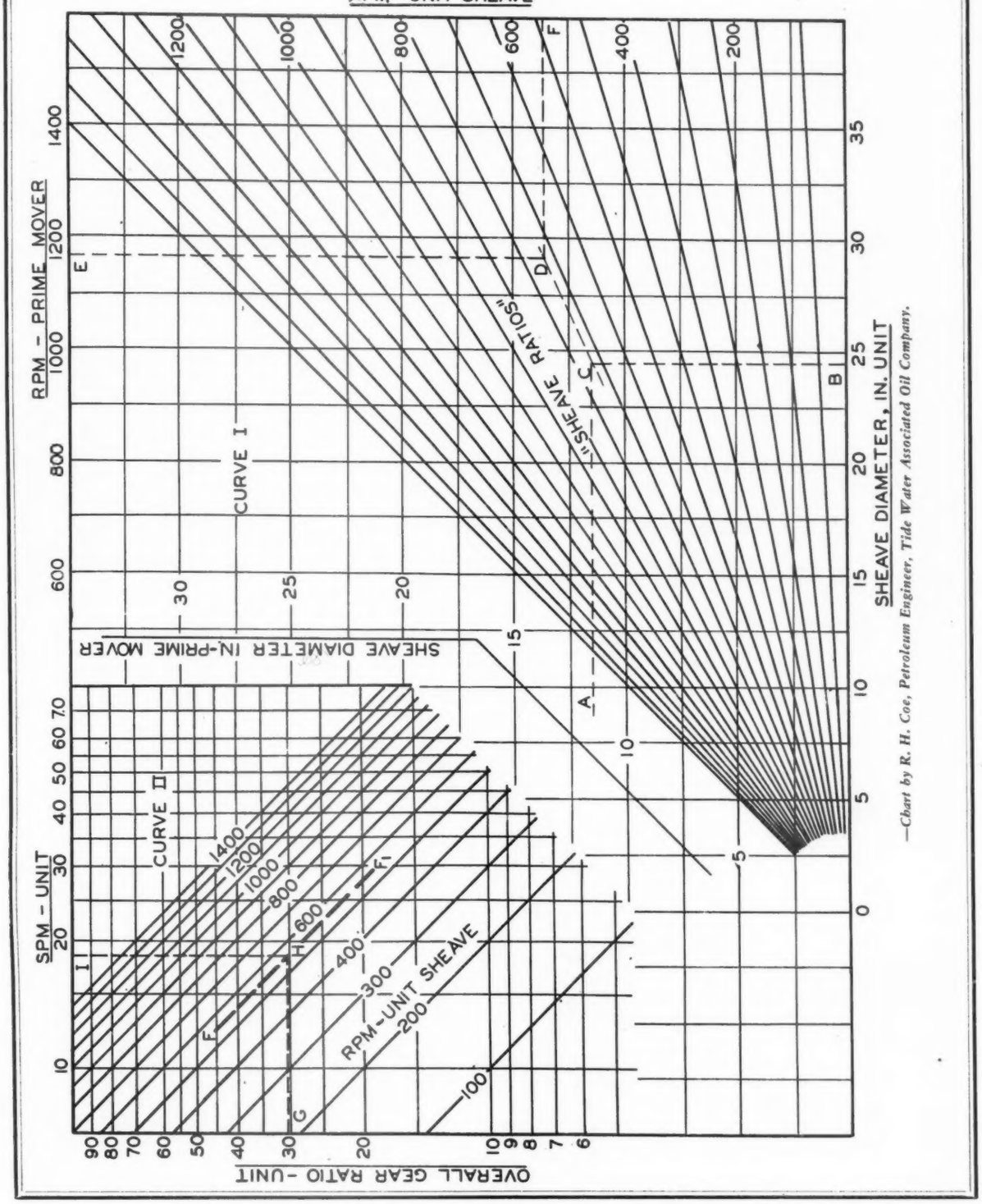
Sheave dia. of Prime Mover (Electric Motor)	11½"
RPM of Prime Mover (Electric Motor)	1170
Sheave dia. of Unit	24½"
Gear Ratio of Unit	30.12
Strokes per Minute	To determine

Solution:

On Curve I, through 11½" or "A" on Sheave Dia. Prime Mover scale draw horizontal line to its intersection at "C" with vertical line drawn through 24½" or "B" on Sheave Dia. Unit scale. Project Sheave Ratio through "C" to its intersection with vertical line drawn through 1170 or "E" on RPM Prime Mover scale at "D". Through "D" draw horizontal line "DF" to RPM Unit Sheave scale. (This value proved to be 549 in this case.)

On Curve II, draw horizontal line through 30.12 or "G" on Overall Gear Ratio Unit scale to its intersection with line 549 or "FF" at "H". A vertical line through "H" to SPM Unit scale gives 18.2 for value of "I", which is strokes per minute of unit under above conditions.

As you will readily see, given any four of the five conditions above, the remaining value may be determined.



—*Chart by R. H. Coe, Petroleum Engineer, Tide Water Associated Oil Company.*

More than half a century ago, Hyatt created the first anti-friction bearing designed to carry the load the full length of a roller.

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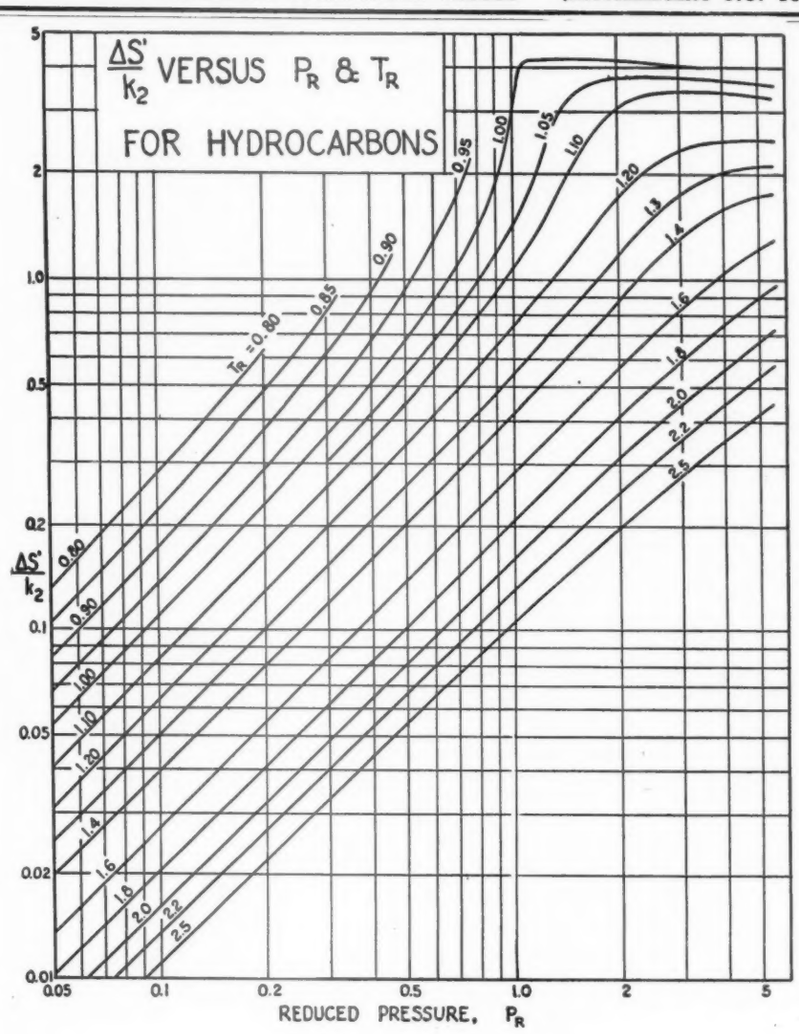
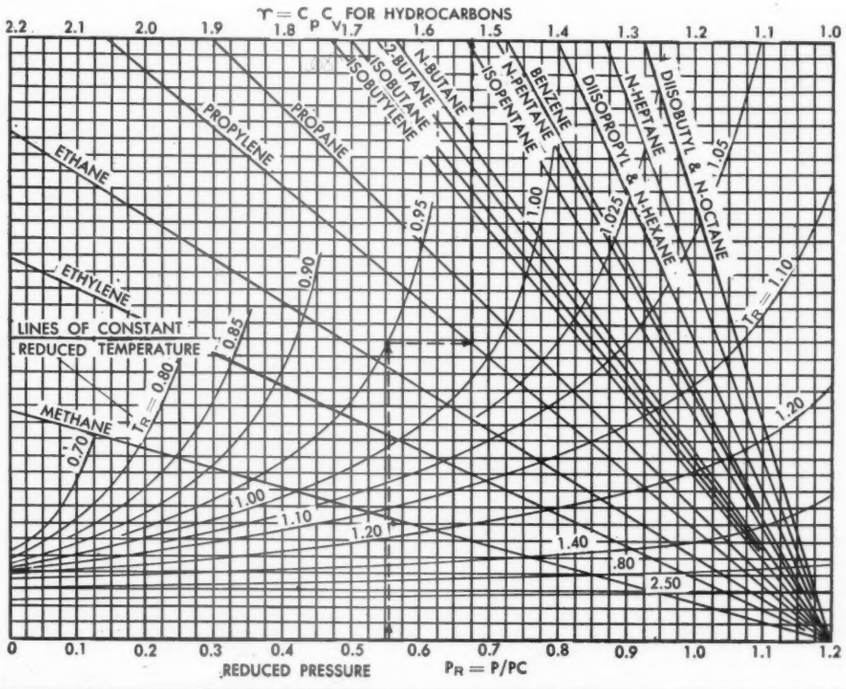
HYATT ROLLER BEARINGS



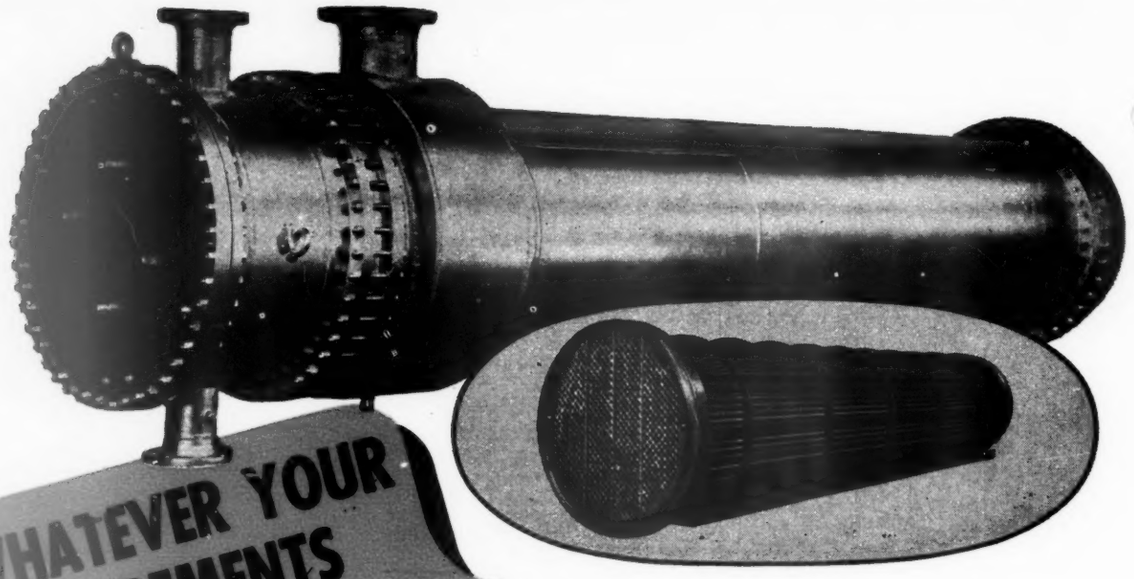


HYDROCARBON THERMODYNAMICS

This series of tables is based on the articles on "Hydrocarbon Thermodynamics," by Wayne C. Edmister, as published in the March, April, and May, 1946, issues of *The Petroleum Engineer*.

Fig. 11 (left) is a generalized plot of the isothermal correction to the enthalpy of vapors as a function of reduced temperature and pressure. By means of Figs. 10 (published in installment No. 108) and 11 (left) and the critical properties, the isothermal effects of pressure on the entropy and enthalpy may be estimated for pure hydrocarbons and their mixtures.

Fig. 12 (below) shows the ratios of specific heats at constant pressure and constant volume as a function of reduced temperature and pressure for various pure hydrocarbon vapors. This chart was developed from specific heats at a constant pressure of one atmosphere. The CpCv values may be determined for mixtures by assuming the values for individual components are additive, or by using pseudocritical conditions and average molecular weights.



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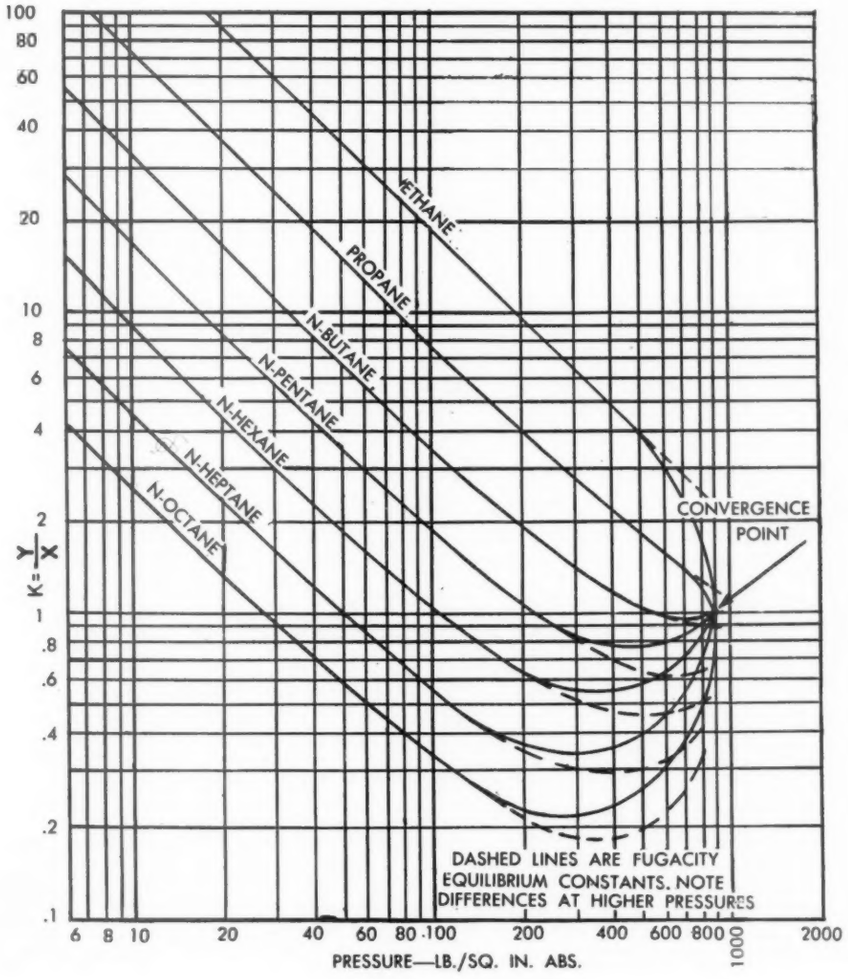
HYDROCARBON THERMODYNAMICS

This series of tables is based on the articles on "Hydrocarbon Thermodynamics," by Wayne C. Edmister, as published in the March, April, and May, 1946, issues of *The Petroleum Engineer*.

Fig. 13 (below) is one of the well-known "K" charts for several light hydrocarbons at 300° F. It will be noted that the curves all converge at a value of K = 1.0 and a pressure of 900 lb. per sq. in. abs.

At the critical point of a mixture there can be no separation into vapor and liquid phases, the mixture being of a homogeneous continuous phase between liquid and vapor. At this point the equilibrium constants for all the components present must be equal to unity to satisfy this condition. Under other conditions of temperature and pressure, the "K" constant curves approach unity also, but at a higher value of pressure. The pressure at which the "K" constants become unity is called the "convergence pressure."



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Since this liquid piston is an integral part of the Nash Compressor, additional liquid can do no harm to the pump structure, whether in the form of slugs entering by accident, or as condensate forming in the suction lines. In handling gases, for example, wet hydrocarbons, usual elaborate protective devices are eliminated. The hazards of such devices are therefore avoided, the cost of installation is saved, and freedom from repairs and shutdowns is assured.

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Original performance corstant over a long pump life.

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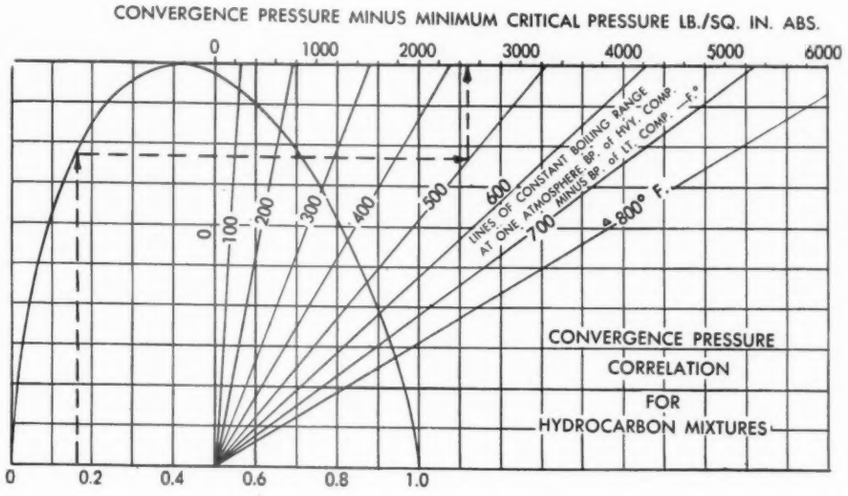
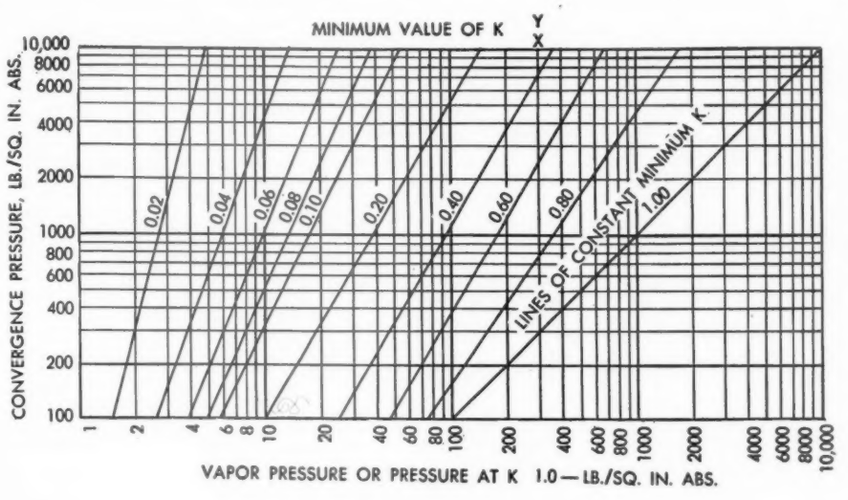
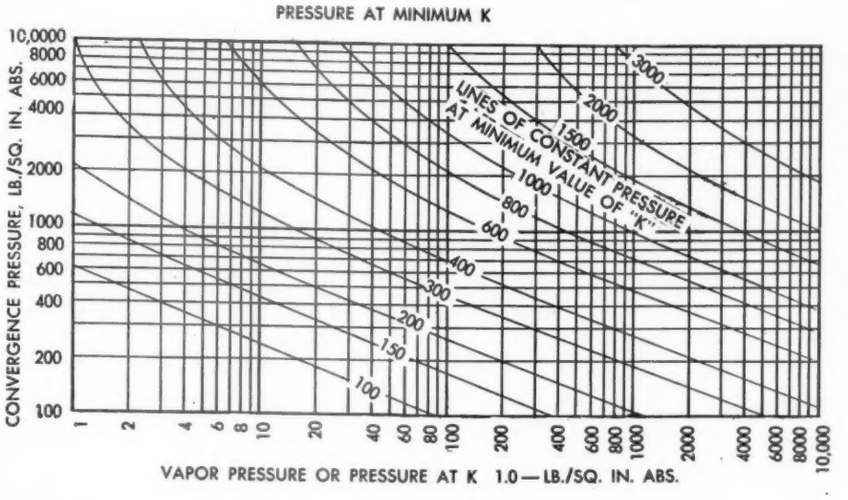




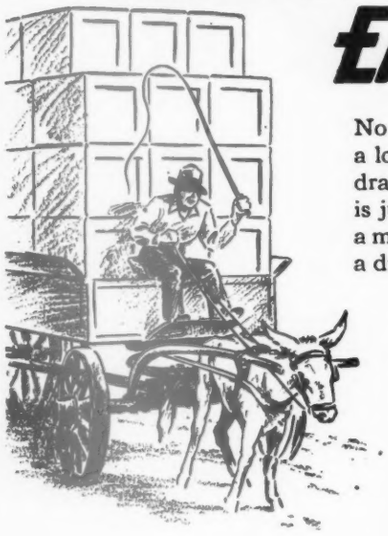


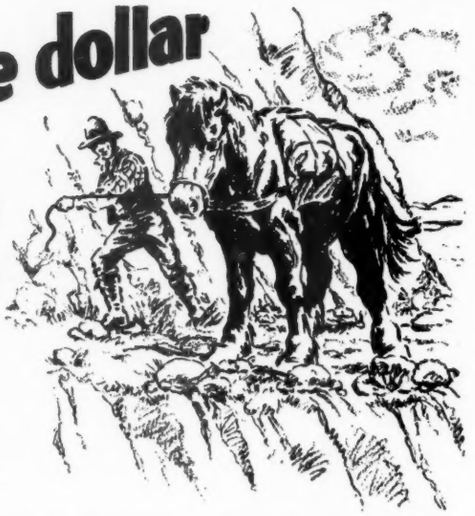
This series of tables is based on the articles on "Hydrocarbon Thermodynamics," by Wayne C. Edmister, as published in the March, April, and May, 1946, issues of *The Petroleum Engineer*.

Fig. 14 (above) gives the approximate value of the convergence pressure or the critical pressure of binary mixtures. It was constructed from critical data in the literature for binary mixtures. Although it is not accurate enough for precise calculations, it indicates the effect of the variables on the convergence pressure.

Fig. 15 (center) and Fig. 16 (below) give the minimum value of "K" and the pressure at this minimum value as a function of the convergence pressure for the mixture and the vapor pressure of the component in question. By means of the correlation presented in Figs. 14, 15, and 16, it is possible to estimate values of "K" where laws of ideal solution do not apply. The use of these 3 charts to construct a plot similar to Fig. 13 (Sheet 10) requires no explanation.

To get *more* for your valve dollar *consult* POWELL *Engineering*





No one would expect a burro to pull a load that requires a heavyweight draft horse. But a sure-footed burro is just right for carrying a pack on a mountain trail where the power of a draft horse would be wasted.

And yet when it comes to valves, such "misapplication" is often encountered. *Many cases of failure are directly due to expecting service from a valve which it was not designed to give.* Consequent replacements are costly. On the other hand, it is not sound economy to use a valve of more expensive construction than the particular service requires. The Powell Line* of Bronze, Iron, Cast Steel and Corrosion Resistant Valves, is so *complete* that there's a POWELL Valve that's *just right* for every flow control condition encountered in modern industry. When you need valves for new installations or for replacements, don't risk "misapplication". Consult POWELL Engineering and *get more for your valve dollar.*

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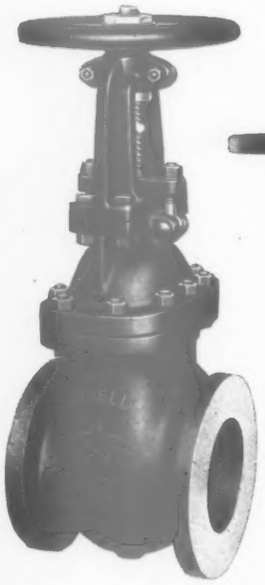
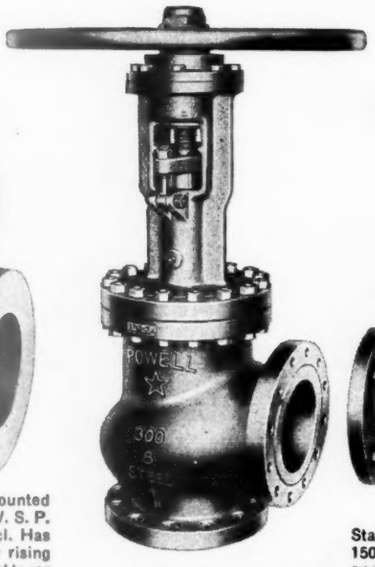
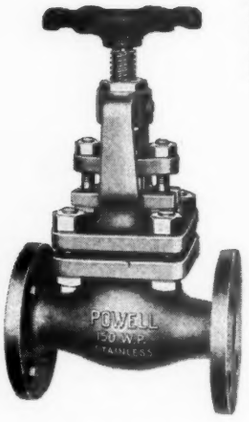


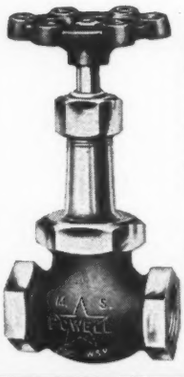
Large Iron Body Bronze Mounted Gate Valve for 125 pounds W. S. P. Made in sizes 2" to 30", incl. Has flanged ends, outside screw rising stem, bolted flanged yoke and taper wedge solid disc. Taper wedge double discs can be provided in sizes 2" to 12", incl. Seat rings and stem are bronze. Disc is bronze in 3½" and smaller size valves and bronze faced in the larger sizes. Also available in All Iron for certain services.

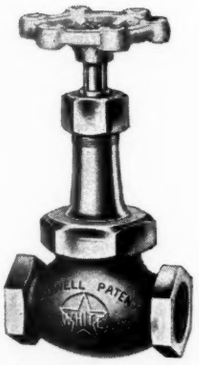


Class 300-pound Cast Steel Angle Valve. Has flanged ends, outside screw rising stem and bolted flanged yoke. Streamlined areas through the body assure maximum flow with minimum pressure drop..



Stainless Steel Gate Valve for 150 pounds W. P. Has flanged ends, outside screw rising stem, bolted flanged yoke-bonnet and taper wedge solid disc. This is one of many special Powell designs for handling corrosive media. Available in a wide range of corrosion resistant materials.





Small Bronze Globe Valve for 200 pounds W. S. P. Made in sizes ¼" to 3", inclusive. Has screwed ends, union bonnet, renewable, specially heat treated stainless steel seat and regrindable, renewable wear-resisting "Powellium" nickel-bronze disc. A long-life valve for severe service conditions.

Small Bronze Globe Valve for 200 pounds W. S. P. Made in sizes ⅛" to 3", inclusive. Has screwed ends, union bonnet and renewable, regrindable hard bronze disc. An economical valve for intermediate steam, oil, water or gas lines.

POWELL VALVES

HYDROCARBON THERMODYNAMICS

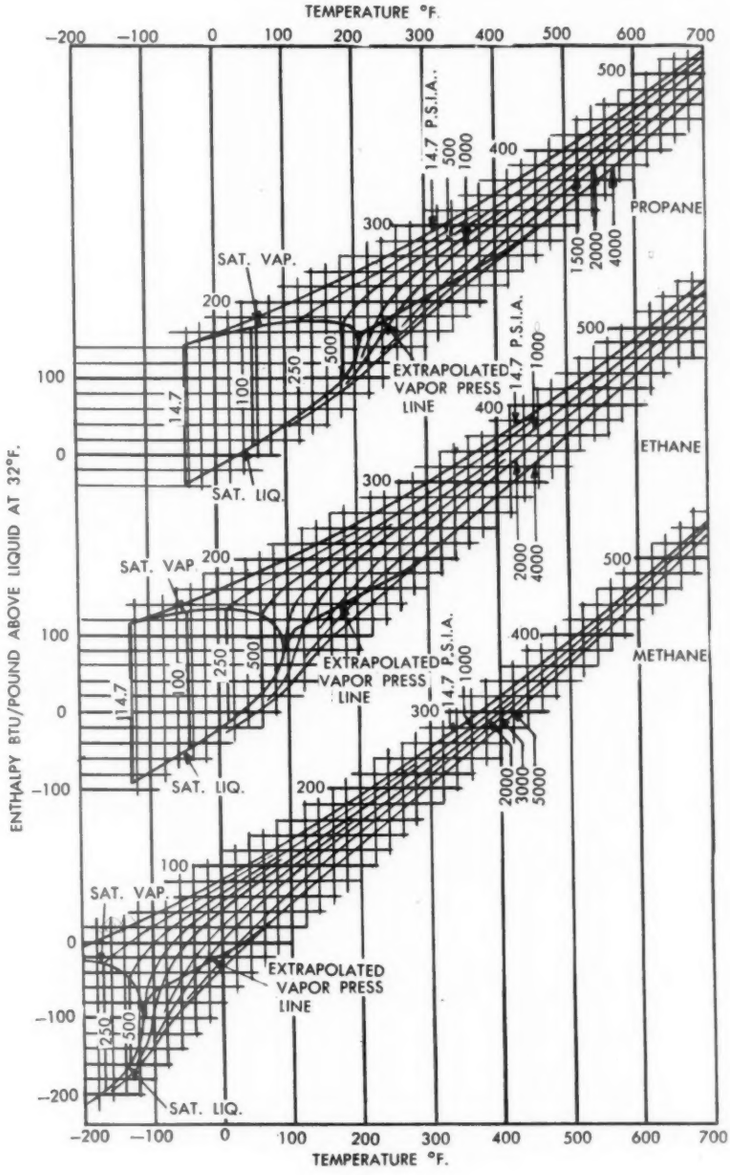
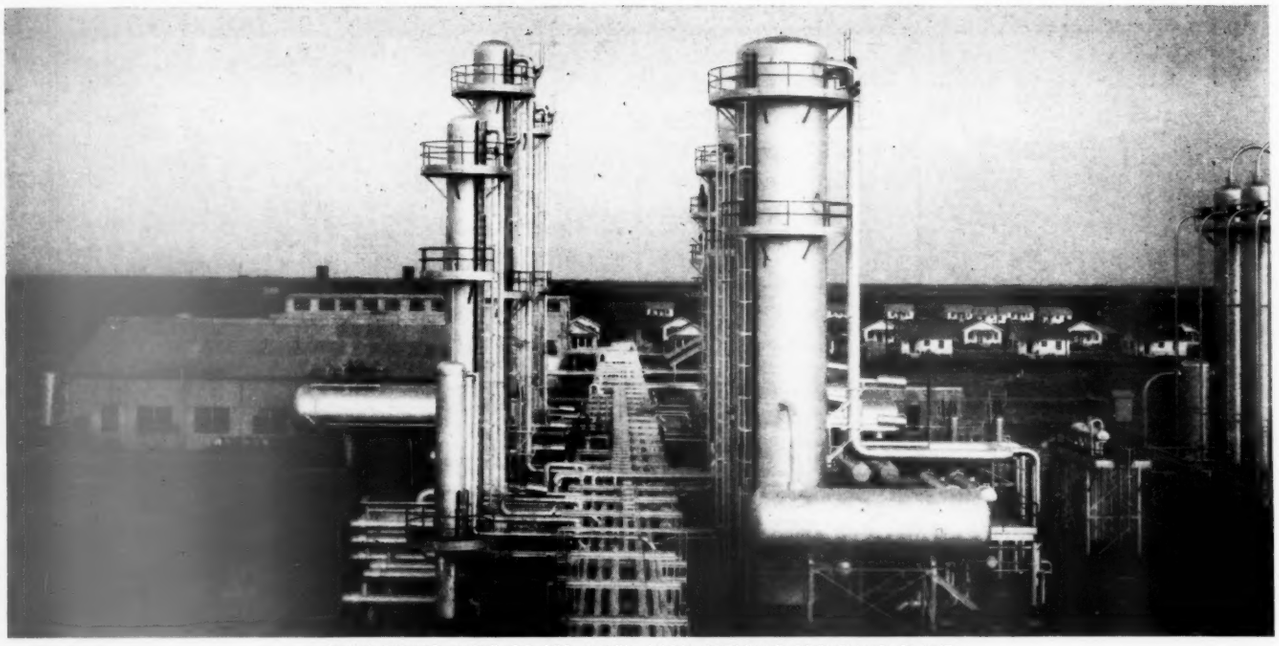


Fig. 17 (above) shows enthalpy plots for methane, ethane, and propane. Similar plots can be made for the entropy. The entropy and enthalpy plots can then be combined to form a Mollier diagram. The datum or reference state for the enthalpy diagrams above is liquid at 32°F., but the datum point for similar diagrams may be selected at any desired temperature for the liquid phase, or it may be vapor at specified temperature and pressure conditions.

This series of tables is based on the articles on "Hydrocarbon Thermodynamics," by Wayne C. Edmister, as published in the March, April, and May, 1946. issues of *The Petroleum Engineer*.

STEARNS-ROGER *goes all the way!*



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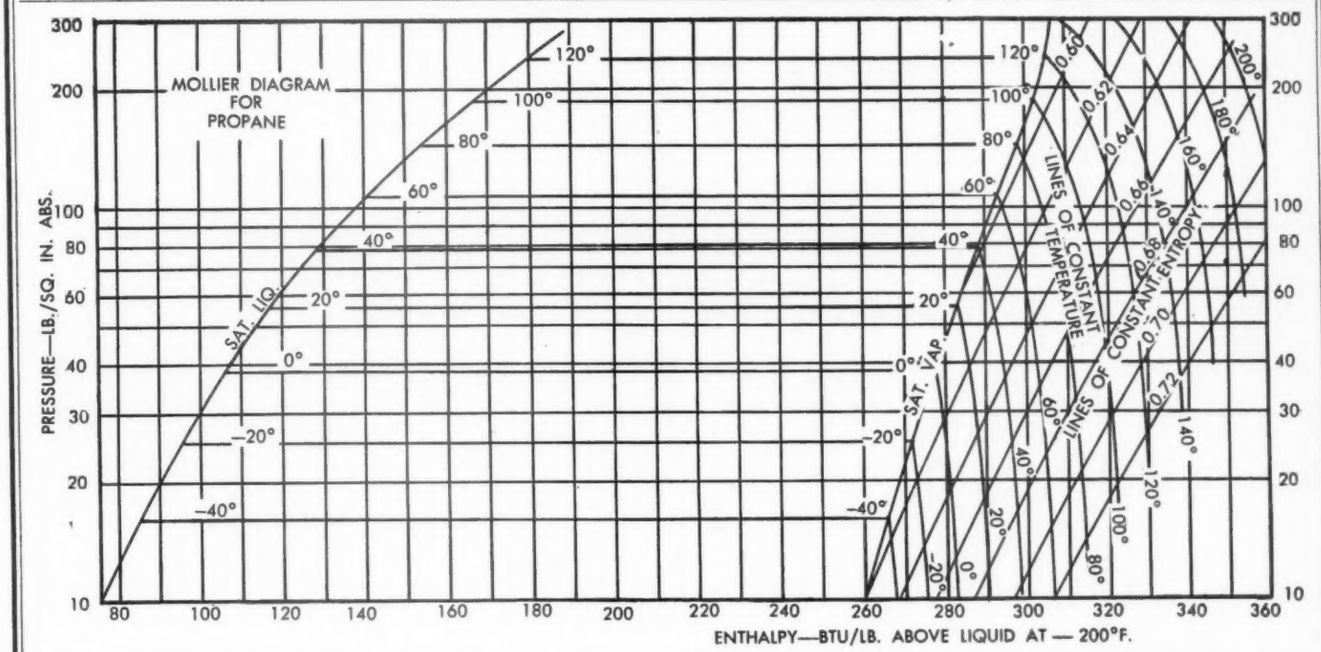

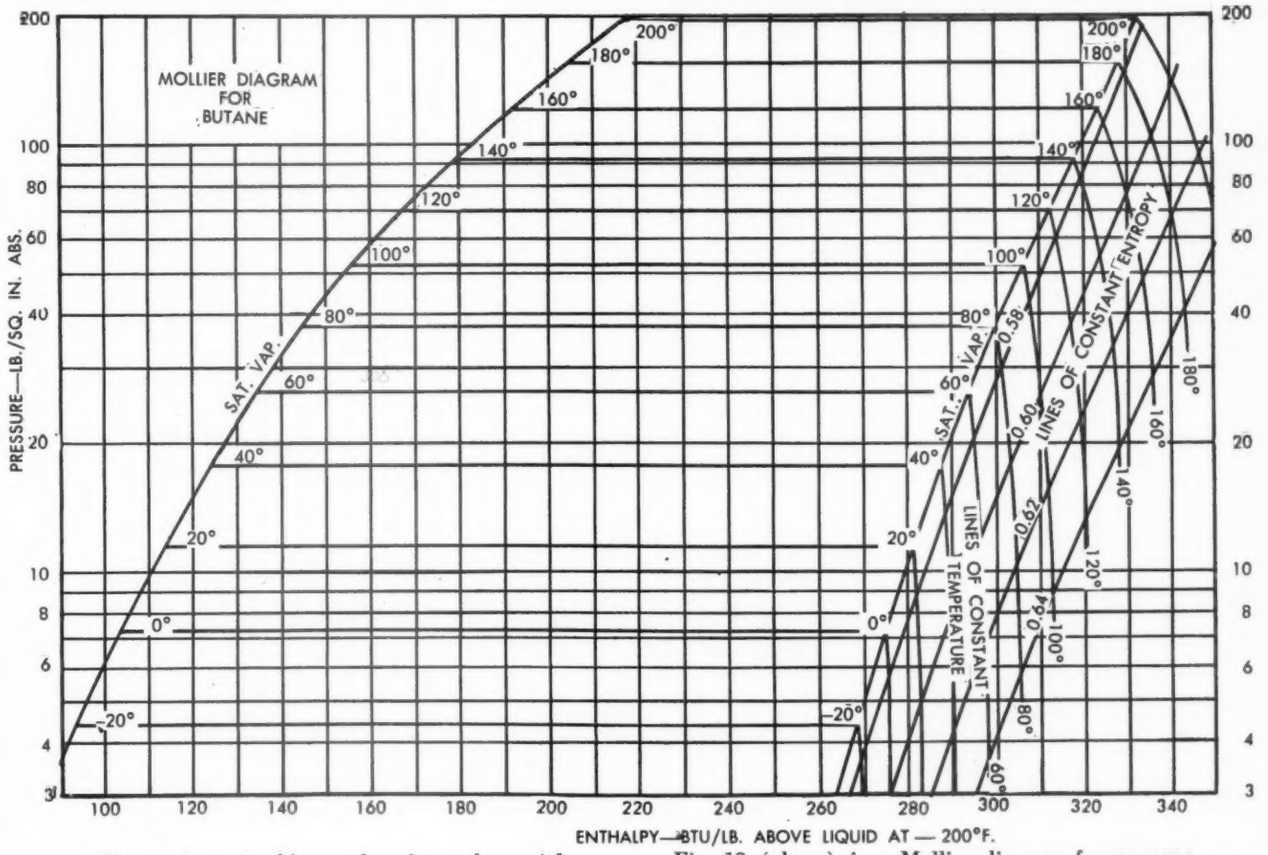

This series of tables is based on the articles on "Hydrocarbon Thermodynamics," by Wayne C. Edmister, as published in the March, April, and May, 1946, issues of *The Petroleum Engineer*.

Fig. 18 (above) is a Mollier diagram for propane with the datum or reference state for enthalpy being liquid at minus 200°F.

Fig. 19 (below) is a similar Mollier diagram for butane.

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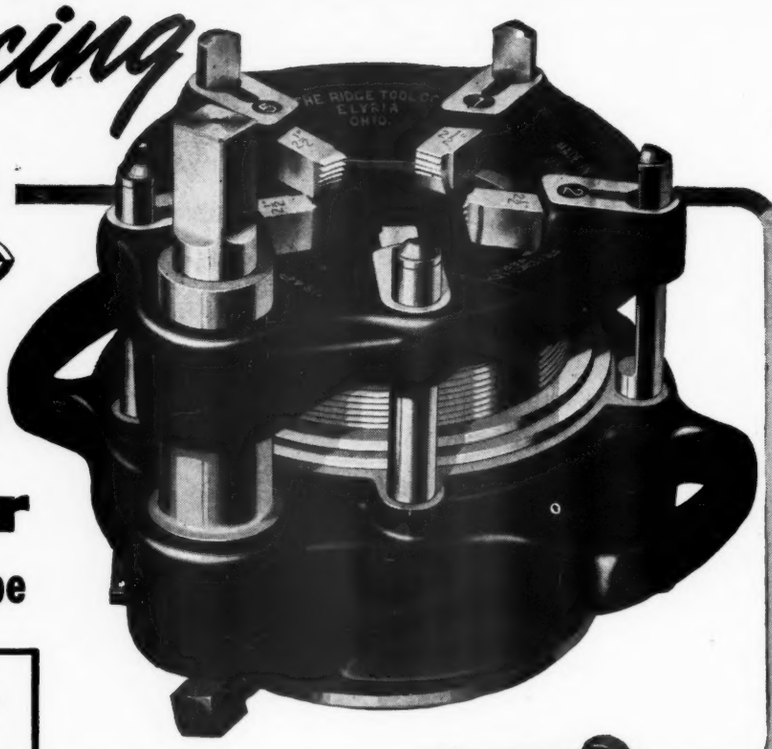

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WORK-SAVER PIPE TOOLS

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Legal problems involved in cycling gas in gas fields*

By H. P. PRESSLER, JR., Humble Oil and Refining Company

● **Introduction.** By gas cycling is meant the production of gas from a gas stratum or from the gas cap of an oil stratum, the processing of the gas for liquefying and extracting some of its heavier hydrocarbon content, and the return of the gas remaining after the extraction of such hydrocarbon content to the reservoir from which produced. This discussion will be confined to the legal problems arising in the cycling of gas produced from a gas stratum, placing particular emphasis upon recent court decisions and legislative acts, with such explanation of the engineering principles involved in gas cycling as may be essential to an understanding of the legal problems.

The hydrocarbons extracted from the gas usually include condensate, gasoline, butanes, propanes, and lighter fractions. The gas remaining after liquefying and extracting a portion of its hydrocarbons is referred to as residue gas.

By statute in Texas a gas well is any well which produces only natural gas or which produces from the same horizon more than 100,000 cu. ft. of natural gas to each barrel of crude petroleum oil[1].

Those hydrocarbons which are produced as a liquid at the mouth of the well because of condensation either in or after they leave the reservoir due to a reduction in pressure and temperature are not usually classified as crude petroleum oil but as condensate[2]

It would seem, therefore, that the statutory definition of a gas well includes wells which produce condensate in liquid form at the mouth of the well in quantities equal to or in excess of one barrel of condensate to 100,000 cu. ft. of gas. These wells are commonly referred to in the industry as "distillate wells" or "condensate wells."

● **Purposes of cycling gas.** The Texas conservation statutes prohibit the burning of natural gas from gas wells and make it unlawful for a producer to permit natural gas from gas wells to escape into the air before or after such gas has been processed. These statutes also prohibit the production of natural gas in excess of transportation or market facilities or reasonable market demand for the type of gas produced. Such acts are defined as waste.[3]

The statutes enumerate the purposes for which gas from a gas well shall be utilized, including in such enumeration the extraction of natural gasoline, *when the residue is returned to the horizon from which produced*, the use for light or fuel, chemical manufacturing (including under certain conditions, the manufacture of carbon black), and pressure maintenance, repressuring, and gas-lift operations.[4]

Thus, the statutes require that the residue of gas produced from a gas well and processed for liquefying some of its hydrocarbon content be returned to the formation from which it is produced or utilized for one of the enumerated purposes. If no cycling plant is available to return the residue gas to the producing horizon, the quantity of gas which can be produced from gas wells and so processed is limited by the quantity of residue gas that can be utilized for some lawful purpose.

In many large gas fields the market demand for gas is not sufficient to permit the operators to produce and process for its heavier hydrocarbon content more than a small portion of the gas which could be produced from the field without injury to the reservoir. There is, however, usually a present demand, and during the war period there has been an urgent demand, for the heavier hydrocarbons extractable from gas. The operators must then elect either to produce and process gas from their leases at a rate which will result in no more residue gas than the market outlet of the field for lawful uses, or to install a cycling plant which will permit them to return to the producing horizon that portion of the residue of the gas they produce and process for which there is no market outlet for lawful uses. Should the gas be of sufficient richness, the reserves be adequate to justify the cost incident to the erection and operation of a cycling plant, and the reservoir conditions be favorable to cycling, the operators will embark upon a cycling program in order to realize a current revenue from the heavier hydrocarbons in the gas. The residue gas returned to the reservoir is stored there until the market demand for it for lawful uses will justify its production as dry gas.

Thus, the usual purpose of cycling operation is to make available immediately the heavier hydrocarbons in the gas and preserve for the future the gas reserves for which there is no present demand.

Cycling operations may serve yet another purpose. In some fields, due to the richness and nature of the gas and reservoir conditions, if large quantities of gas are produced and reservoir pressure is reduced, a substantial amount of the heavier hydrocarbons in the gas will condense in the reservoir. This is called retrograde condensation. Such portions of the hydrocarbons which condense in the reservoir are not recoverable. If cycling operations are conducted in fields of this type, the residue gas returned to the formation maintains the reservoir pressure and prevents the loss of hydrocarbons due to retrograde condensation.

● **Importance of gas cycling.** As a result of the war there was an enormous increase in the demand for liquid hydrocarbons extracted from gas. They are used in the manufacture of aviation gasoline, constituents of synthetic rubber and numerous chemicals essential to the war program as well as motor fuel. Emphasis has been added to the importance of cycling operations by the fact that in late years the ratio of gas or gas condensate reserves discovered in proportion to oil reserves has increased materially. In a recent survey it was found that in the United States there were 224 fields considered primarily gas condensate fields, 151 being located in Texas, 60 in Louisiana, 8 in Arkansas, 3 in California, 1 in Wyoming, and 1 in Mississippi.

Not long ago the discovery of a gas condensate field was a great disappointment to the oil operator. With the development of cycling operations this is no longer true. The cycling industry is new but is experiencing a rapid growth, and great progress has been made toward a solution of the engineering problems involved.[5] It has been estimated that the construction program in the natural gasoline, cycling and pressure maintenance operations in the oil industry will approximate an expenditure of $3,000,000 per month during 1945.[6]

In the Texas and Louisiana Gulf Coast

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[1]"The term 'gas well' is any well (a) which produces natural gas not associated or blended with crude petroleum oil at the time of production, or (b) which produces more than one hundred thousand (100,000) cubic feet of natural gas to each barrel of crude petroleum oil from the same producing horizon, or (c) which produces natural gas from a formation or producing horizon productive of gas only encountered in a well bore through which crude petroleum oil also is produced through the inside of another string of casing." *Tex. Stat.* (Vernon, 1936) art. 6008, §2(d).

[2]Clymore Production Co. v. Thompson, 13 F. Supp. 469 (W.D.Tex. 1936); Ray v. Arkansas-Louisiana Gas Co., 200 La. 233, 7 So.(2d) 895 (1942).

[3]"The production, transportation, or use of natural gas in such manner, in such amount, or under such conditions as to constitute waste is hereby declared to be unlawful and is prohibited. The term 'waste' among other things shall specifically include:

"(d) Permitting any natural gas well to burn wastefully.

"(h) The production of natural gas in excess of transportation or market facilities, or reasonable market demand for the type of gas produced.

"(k) Permitting any natural gas produced from a gas well to escape into the air before or after such gas has been processed for its gasoline content." *Texas Stat.* (Vernon, 1936) art. 6008, §3.

[4]*Id.* §7.

[5]Short, *"Texas Cycling Operations Increase 15-Fold During Past 7 Years"* (1945) 44 *Oil and Gas J.* 120, 123.

[6]Norman, *"Natural Gasoline"* (1945) 43 *Oil and Gas J.* 179.

area there were only 14 cycling plants in operation early in 1940. All these plants were comparatively new and handled an aggregate of approximately 743,000,000 cu. ft. of gas per day, extracting therefrom approximately 18,000 bbl. of liquid, primarily condensate. Today in this same area there are 35 cycling plants in operation, processing a total of approximately 2,486,000,000 cu. ft. of gas per day and extracting therefrom approximately 79,200 bbl. of liquid hydrocarbons. Approximately 70 per cent of the gas processed in these plants is returned to the formations. This means that without the cycling plants materially less gas could be processed, and the recovery of liquid hydrocarbons would be reduced substantially.

It is thus seen that gas cycling is an increasingly important operation in the oil and gas industry.

● **Voluntary cooperative Development agreements essential to cycling operations.** In cycling operations the residue gas returned to the formation mechanically displaces the wet gas. In order for this displacement to function with the greatest efficiency and to prevent wet gas from being cut off from producing wells into pockets by the dry gas fingering through the formation, it is necessary that the residue gas be returned to the formation through input wells located within a reasonably restricted area, so that such gas will expand from the injection points toward producing wells located properly with relation ot the input wells.[7] Therefore, cycling operations should be conducted under a program planned for the field as a whole so that input and production wells can be located in accordance with best engineering practice and without regard to property or lease lines. Unless the leases in the field each cover relatively large tracts, such a program cannot be effected by cycling operations on separate leases. Each lease owner and royalty owner will object to a program which, though advisable for the field as a whole, requires the injection of residue of gas from other tracts through input wells on or near his lease, resulting in the early displacement of the wet gas under his lease by the residue gas.

To meet these objections an input well and a producing well must be drilled on each separate lease if the cycling operations are to be conducted on separate leases. This will usually prevent wells from being located in conformity with best engineering practice and will result in the drilling of input and producing wells which would not be necessary under a comprehensive plan for the field as a whole, thus increasing the cost of a cycling operation to such an extent that it will be economically unfeasible in many fields.

Therefore, the pooling, either into one unit or into several units of substantial size, of all or most of a gas field and its development and operation under a cooperative plan are essential to cycling operations in accordance with a comprehensive plan for the field as a whole. Such pooling will eliminate the objections of the lessees and royalty owners to the displacement of the wet gas under their tracts with residue gas as they will participate in the production of wet gas from other portions of the unit.

The Texas Legislature has recognized the necessity of cooperative development and operation of gas fields. In 1935 the Texas statutes were amended[8] so as to authorize any two or more lessors, lessees, operators, or other persons owning interests in separate properties in a producing gas field to enter into agreements for the cooperative development and operation of all or parts of the field and for fixing the time, location and manner of drilling and operating wells for the production, storage, marketing or repressuring of gas *or for the equitable distribution of royalty payments.* These agreements must have the approval of the attorney general and are binding only on the parties thereto and their successors and assigns with notice.[9] Under this provision the gas and gas rights in many gas fields have been unitized by voluntary agreements and agreements have been made for the cycling of gas in the fields under cooperative plans. As of November, 1944, cycling operations were being conducted in 31 fields in the state.

The largest operation of this kind in Texas and one of the largest in the world is being conducted in the Katy gas field, in Waller, Harris, and Fort Bend counties. This field comprises approximately 30,000 acres. The unit originally pooled contained 11,285.35 acres and was thought to comprise practically the entire field. There is now a second unit, including the balance of the acreage, approximately 19,000 acres, in the field as its limits are now defined. This second unit was formed by pooling units not in excess of 800 acres each under pooling agreements providing for the merger of these small units after a producing gas well had been drilled thereon, and these units of less than 800 acres have now been merged or consolidated into one unit.

In order properly to effectuate a cycling program by voluntary agreements there must be cross assignments between the lesees of their leasehold interests or such interests must be unitized so that as a result of such assignments or unitization each lessee will own the same leasehold interest as to gas in all tracts included in the unit. The development and the operation of the leases in the unit should be vested in one operator who should develop and operate them for the cycling of gas according to a comprehensive plan for the field as a whole. Provision should be made for each lessee to participate in the field's market outlet for residue gas on some fair and equitable basis.

It is always possible that oil will be discovered in the formation (usually around its edges) from which the gas is produced, and, therefore, in effectuating agreements for cycling, it should be provided that the owner of the oil rights under the lease on which the well is located may take over the oil well, and, should he fail to do so, that the owners of the gas rights shall own such well and the production therefrom.

When the royalty interests, or a substantial portion thereof are unitized as to gas, specific provision must be made for allocating the production among the tracts in the unit either on the basis of surface acres, acre-feet of gas sand, gas reserves or some other fair and equitable basis. If a term royalty interest is involved, it is especially important that the owner of the reversionary interest should execute the pooling agreement. Othewise, the term royalty will not be maintained in effect by production of gas from the unit if such production is not from the particular tract affected by the term royalty. Provision must be made for the development of the unit as an entirety and the location of producing wells or input wells without regard to lease or property lines. It must be agreed that no royalties shall be due on residue gas returned to the producing formation or other formations in the field or on gas lost in handling, consumed or lost in plant operations, used for development of the unit, or furnished to the lessors in the leases in accordance with their terms. Provision should be made for proper deductions for all outages and for the deduction of production, severance, sales, and other direct taxes in connection with the payment of royalties. The pooling agreement should also contain provision that drilling or reworking operations upon, or production from, any of the pooled leases shall be considered for all purposes except the payment of royalties as drilling or reworking operations upon, or production from, each of the pooled leases.

Specific provision must be made for computing the royalties on the liquid hydrocarbons extracted. Cycling plants cannot be considered lease equipment, and the cost of their erection and operation is not a mere lease expense. The cost of these plants usually runs into several millions of dollars. The portion of the extracted liquid hydrocarbons upon which the royalty will be based varies with different fields, controlled to some extent by the richness of the gas. Some pooling agreements provide for the computation of royalties on only 40 per cent of the extracted products, while others provide for royalty payments to be computed on as much as 100 per cent of the recovered products. In the writer's opinion, this is the only feature of a cycling program which may involve any conflict of interest between the lessees, plant operators, and the royalty owners.

● **Powers of the Railroad Commission of Texas with reference to cycling.** Thought no authority has been given to the Railroad Commission of Texas to *require* cycling, unitization, or coopera-

[7] Bennett, "*Location of Producing and Input Wells for Pressure Maintenance and Condensate Recovery Projects*," and Swearingen, "*Predicting Wet Gas Recovery in Recycling Operations*," appearing in series of technical articles on gas recycling and distillate recovery.

[8] *Texas Laws* (1935) §120.

[9] *Tex. Stat.* (Vernon, 1936) art. 6008, §21.

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tive development and operation of gas fields, the Commission has been granted authority which empowers it to enforce rules and regulations which will encourage cycling operations in *gas fields* and protect the correlative rights of operators engaged in such operations from injury resulting from withdrawals of gas by other operators in the field.

Section 10 of article 6008 of the statutes authorizes the Commission to prorate and regulate gas production from common reservoirs for the prevention of waste and for "the adjustment of correlative rights and opportunities of each owner of gas in a common reservoir to produce and use or sell such gas . . ."

Section 11 of the same article provides that the Commission shall exercise its authority to adjust correlative rights and opportunities of each owner to produce when the aggregate lawful volume of the open flow or daily potential capacity to produce of all gas wells in a common reservoir is in excess of the daily reasonable market demand for gas from such reservoir.

Section 12 provides for hearings by the Commission to determine the aggregate daily capacity to produce of the gas wells in a common reservoir and the daily volume of gas which will be produced during the following month from the reservoir for lawful purposes and for the allocation to each gas well of its daily allowable production.

Section 13 enumerates the factors to be used in determining daily allowable production of each gas well, and section 14 declares it to be the duty of the Commission after hearing to determine the reasonable market demand for gas from gas wells for lawful purposes and to restrict the production of gas from a field to an amount equal to market demand or to an amount which may be produced without waste as otherwise defined and contains a proviso that the production of gas shall in any event be restricted to the amount of reasonable market demand.

Section 15 stipulates certain percentages of the daily productive capacity of gas wells below which the Commission cannot restrict production.

Section 16 declares it unlawful for any person to produce gas from a gas well in excess of its daily allowable and provides that the rate of production from any gas well shall be deemed to be the average daily production for the month.

Because of the decision of the Supreme Court of the United States in the case of *Consolidated Gas Utilities Corp. v. Thompson*,[10] the Railroad Commission has heretofore taken the position that in the absence of "waste" it did not have the authority to allocate the market demand for gas from a gas field among the wells in that field in order to protect the correlative rights of the owners of gas in the field.[11] This situation has been recently clarified by the decision of the Texas Supreme Court in the case of *Corzelius et al. v. H. M. Harrell.*[12] The *Corzelius* case involved the Bammel gas field. In 1939 Harrell owned leases on most of the acreage in the field and constructed a cycling plant in the field. He produced approximately 35,000,000 cu. ft. of gas per day from his leases, extracted the liquid hydrocarbons and returned 33,000,000 cu. ft. of gas to the reservoir, 2,000,000 cu. ft. being used in plant operations or unavoidably lost. Corzelius acquired leases on approximately 4 per cent of the field, and in 1942 began producing four or five million cubic feet of gas per day, which he supplied through a pipe line, from the field to Houston, to two distributing corporations owned by him. Harrell sought to obtain an order from the Railroad Commission prohibiting permanent withdrawals from the field until the conclusion of the cycling program, asking, in the alternative, that withdrawals be prorated. The Commission found that production up to 20,000,000 cu. ft. of gas daily would not result in appreciable waste and authorized withdrawals up to that amount. Harrell brought the suit as an appeal from the Commission's order, and the trial court entered judgment cancelling the order, enjoining the Commission from entering similar orders, and permanently enjoining Corzelius from producing under the cancelled order or any similar order. Subsequent to the trial court's judgment, the Commission entered a new order substantially different from the original order. This new order was never attacked, as Corzelius' well blew out, caught fire, and was killed after it had burned for many months, Harrell having acquired title to the well and the lease on which it is situated.

The Texas Supreme Court held that, although the case had become moot, the judgment of the trial court should not be allowed to stand, because it would leave doubt as to whether the Commission has any authority to regulate gas production in the Bammel field. The court rejected the construction which had been placed upon article 6008 by the three-judge court in the *Consolidated Gas* case (Footnote 10), *i.e.*, that the statute does not authorize the Commission to "adjust correlative rights" except where waste is involved, stating that the United States Supreme Court had not accepted that interpretation of the statute, and asserting that the statute, as construed to give the broader power, is constitutional. The following passages from the court's opinion state its view of the meaning of the statute:

"In this case we are concerned with the production of natural gas in a gas field, and also with the question of correlative rights of the various owners of properties in such field. Subsections (a) and (b) of Section 10 of Article 6008 are not dependent on each other. *They are coordinate, and each has its own independent standing in this law.* Unquestionably we think that Section 10 of Article 6008 authorizes the Railroad Commission to prorate and regulate the daily gas well production from each common reservoir, in order to prevent waste and adjust correlative rights as provided for in such Subsections (a) and (b)."[12a] (Emphasis the author's.)

This decision removes any doubt but that when the aggregate lawful volume of gas which can be produced from a common reservoir exceeds the market demand therefor, the Railroad Commission has the power, even where there is no "waste," as that term is defined in the Texas statutes, to regulate and prorate the daily production among the wells producing from the reservoir for the protection of correlative rights and in order to give each owner of gas in the reservoir the opportunity to produce and use or sell his pro rata portion of the gas.

With this power, the Commission can

Drilling in Iran

Reports from Tehran newspapers and travelers in Iran say that Russians are drilling at various spots south of the Caspian Sea. The places are said to be from Azerbaijan to Gurgan, north Iran, in the concession recently granted the Soviet.

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[10] Consolidated Gas Utilities Corp. v. Thompson (Three-Judge Federal Court), 14 *F. Supp.* 318 (W.D.Tex. 1936).

Thompson v. Consolidated Gas Utilities Corp., 300 U.S. 55 (1937).

This suit involved an order of the Railroad Commission dividing the Panhandle gas field into two zones and allocating the total allowable among the various sweet gas wells in each zone based one-half upon a consideration of relative potentials and one-half on relative acreage up to the efficient drainage area of the wells as found by the Commission. Consolidated attacked the order, claiming it was operating its wells without waste and that such wells produced at lawful rates would supply Consolidated's private contract for sale of gas from the field and alleged that the purpose and effect of the statute and order were to divide the plaintiff's market with producers who had no market for their gas, contrary to the Constitution of the United States.

Texoma Natural Gas Company brought a similar suit, and the two suits were consolidated, and after hearing, the three-judge federal court granted permanent injunctions restraining the enforcement of the order as to them.

The evidence showed that the migration of gas or drainage was from, not to, the wells connected to the pipe lines of the Consolidated and Texoma companies. The three-judge court held that the order was not enacted to prevent waste but to compel purchase of gas on the theory of protecting correlative rights, and, therefore, invalid.

The Supreme Court of the United States affirmed the decision of the three-judge court but said in part:

"We assume that the prohibition of any wasteful conduct, whether primarily in behalf of other owners of gas in the common reservoir, or because of the public interests involved, is consistent with the Constitution of Texas and that of the United States, and that to prevent waste production may be prorated. *We assume, also, that the State may constitutionally prorate production in order to prevent undue drainage of gas from the reserves of well owners lacking pipe line connections.* If proration were lawfully applied for any such purposes, the fact that thereby other private persons would incidentally and gratuitously obtain important benefits would present no constitutional obstacle. And the fact that plaintiffs' gas is to be sold in interstate commerce would not preclude such exercise of the state's power." 300 U.S. at 70. (Emphasis the author's.)

[11] Transcript of testimony of a hearing held by the Railroad Commission of Texas, Oil and Gas Division, in Austin, Texas, February 26 and 27, 1942, Oil and Gas Docket No. 128, 3-3414, conservation and prevention of waste of crude petroleum and natural gas in the Bammel field, Harris County, Texas, pp. 33-39.

[12] 186 S.W.(2d) 961 (Tex. Sup. 1945). See also other opinions in connection with the controversy between Harrell and Corzelius. Corzelius v. Harrell, 179 S.W.(2d) 419 (Tex.Civ. App. 1944); Corzelius v. Railroad Comm., 182 S.W.(2d) 412 (Tex.Civ.App. 1944).

[12a] 186 S.W.(2d) at 968.

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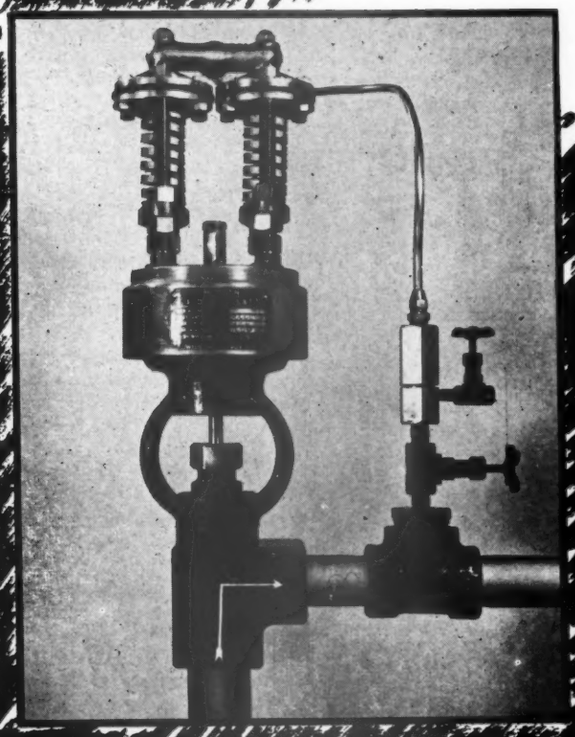

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allocate among the producers in a gas field the market demand for the field so as to prevent one or more producers from marketing gas from the field to the exclusion of the other producers and to protect such other producers against the invasion of their correlative rights where such other producers are engaged in cycling operations. The Commission can also prorate for the same purposes among the gas wells in a common reservoir the quantity of gas which is produced from the field for processing and cycling.

These powers, though not authorizing the Commission to require cycling or unitization, are such that it can enforce rules and regulations which will materially assist operators in conducting cycling operations, give them substantial protection from injury by withdrawals of gas by non-cooperating operators and at the same time give substantial protection to an operator who may not have been included in a voluntary cycling program.

● **Compulsory cycling and unitization in other states.** In a discussion of the powers of the Railroad Commission of Texas with reference to cycling, it will be of interest to review the authority on this subject vested in the regulatory bodies of other states.

In 1940 the Louisiana Legislature passed Act 157, under the provisions of which the Louisiana Commissioner of Conservation is authorized to *require* the cycling of gas, to promulgate rules to unitize separate ownerships, and to regulate the production of gas and the reinfroduction of gas after the extraction of its liquid hydrocarbon content.[13] This Act also authorizes the Commissioner to establish a drilling unit or units for each pool except those so developed prior to the Act as to render unitization impracticable, and defines a drilling unit.[14]

The Act further provides that where separately owned tracts are embraced within an established drilling unit the owners may validly agree to pool their interests and develop their lands as a drilling unit and authorizes the Commissioner to require pooling to prevent waste and avoid the drilling of unnecessary wells if such owners fail to agree to pool.[15]

Cycling operations are now being conducted in several fields pursuant to orders, issued under the authority of this Act, compelling the unitization of the field. These fields include the Erath gas field in Vermilion Parish, the largest cycling project in the state and one of the largest in the world.[16]

The constitutionality of this Act has been put in issue in suits attacking the orders of the Commissioner establishing units in gas fields under the provisions of Section 8(b) and 9(a) of the Act. The Act and orders issued thereunder have been upheld by the courts, and the Louisiana Supreme Court has stated that the existence of waste is not a necessary prerequisite to unitization orders, but that such orders are valid where issued for the prevention of waste which may occur in the future and to prevent the drilling of unnecessary wells.[17]

In upholding an order entered under statute, which required the establishment of 320-acre compulsory drilling units in the Logansport gas field, the court stated:

"The fact that there may have been no waste or wasteful use of gas in the Logansport field, in the ordinary sense in which the word 'waste' or the term 'wasteful use' is used, is no reason why the commissioner should not have taken steps for the prevention of waste and to avoid the drilling of unnecessary wells in that field. The purpose of establishing drilling units, as expressed in section 8 (b) of the statute, is not merely to stop the wasting of gas which is already going on."[18]

The Supreme Court of the United States in dismissing the appeal for want of a properly presented federal question pointed out that the order attacked in the state's suit had been superseded by another order, but said with reference to the constitutionality of the statute:

"We have held that a state has constitutional power to regulate production of oil and gas so as to prevent waste and to secure equitable apportionment among landholders of the migratory gas and oil underlying their land, fairly distributing among them the costs of production and of the apportionment. . . . On this appeal, absent from the record any operative order implementing Act No. 157, we cannot say that the application of the Act can be enjoined as invalid on its face, for we cannot say that no order could be made by the Commissioner which would apportion the production and distribute the costs of production and of the apportionment in a manner which would be consonant both with the requirements of the statute and the Federal Constitution, . . . It will be time enough to consider the constitutionality of any particular apportionment and distribution of costs when we have before us the specific provisions of an order directing them which has been subjected to the scrutiny of the state court."[18a]

Of interest are the decisions of the Louisiana Supreme Court in three other cases arising from the unitization orders promulgated for the Logansport field. In this field the Commissioner first established a 320-acre drilling unit but after the issuance of Order M-68 by the Office of Production Management, amended his order to require 640 acre drilling units.

In the case of *Hood v. Southern Production Company, Inc., et al.*,[19] the court held that the amendment of the printed lease form by deleting the clause providing for pooling did not interfere with the Commissioner's authority to compel the unitization of the land leased on the amended form. The court also held that the offset clause of the lease had no application to a gas well drilled on the unit including the lease in question but located on another lease.

In *Hardy et al. v. Union Producing Company et al.*[20] production from a unit created by the Commissioner's orders and including a 47-acre lease was held to maintain the lease in force and effect after the expiration of its primary term though the producing well was not on the 47-acre lease and the lessor had executed no pooling agreement. The lease involved was executed prior to the passage of Act 157.

A unitization order of the Commissioner was held in *Alston v. Southern Production Company, Inc., et al.*[21] to supersede contracts between landowners and leaseholders made under the authority of the previous orders.

The conservation laws of Arkansas[22] and New Mexico[23] provide for compulsory pooling of separately owned tracts in established drilling units, but make no provision for requiring cycling operations or compulsory pooling reasonably necessary for such operations.

[13]La. Acts (1940) 610, Act 157, §4(b).
[14]*Id.* §8(b).
[15]*Id.* §9(a).
[16]"*Erath Cycling Project One of World's Largest*" (1945) 43 *Oil and Gas J.* 60, 69-71.
[17]Hunter Co., Inc. v. McHugh, 320 U.S. 222 (1943); Hunter Co., Inc. v. McHugh, 202 La. 97, 11 So.(2d) 495 (1942); Alston v. Southern Production Co., Inc., 21 So.(2d) 383 (La.Sup. 1945).
[18]Hunter Co., Inc. v. McHugh, 202 La. 97, 135, 11 So.(2d) 495, 507 (1942).
[18a]Hunter Co. v. McHugh, 320 U.S. 222, 227 (1943).
[19]Hood v. Southern Production Co., Inc., 206 La. 642, 19 So.(2d) 336 (1944).
[20]Hardy v. Union Producing Co., 20 So.(2d) 734 (La.Sup. 1944).
[21]Alston v. Southern Production Co., Inc., 21 So.(2d) 383 (La.Sup. 1945).
[22]Ark. Acts (1939) Act 105, §15.
[23]N.Mex. Laws (1935) c. 72, §12.

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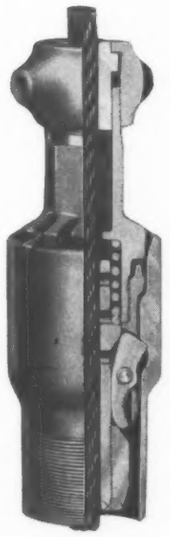


FULLY AUTOMATIC: When the tools are lowered into the hole, the Wire Line Wiper automatically latches into position on the body and stays there throughout the round trip, keeping the line clean and dry. As the rope socket on the wire line tool comes out of the hole, it contacts the automatic latch at the bottom of the Wiper and the pack-off assembly instantly releases from the body, riding out on top of the tool. No flagging is necessary . . . no slowing down of line speed . . . and tools can be readily withdrawn and inspected on every trip!

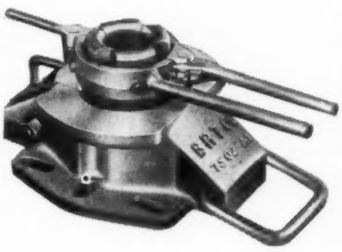
SEGMENTED PACKING: Note in the cutaway view how the packing is in separate rings. This gives more wiping edges for a cleaner line. It also permits replacement of worn portions without having to replace entire packing.

NON SPARKING: And here's a vital advantage . . . a split bronze bushing inserted around the wire line in the cap eliminates risk of steel-to-steel sparking. Greater safety around gassy wells!

There are many other unique features engineered into this tool. And it's available in a complete range of sizes to fit all pipe from 3" to 9"!

Maximum Working Efficiency!

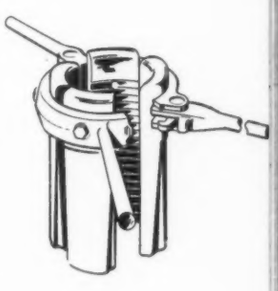
THE BAASH-ROSS OPEN END TUBING SPIDER



With the Open End Tubing Spider your crews can save time in rigging up for tubing work, can work faster and more efficiently, and get on to the next job sooner.

To install the Open End Tubing Spider, simply remove the dovetailed end gate, slide the Spider around the tubing, replace the end gate and insert a bolt. It's simple, quick and there's no need even to break connections. Moreover, the end gate tongues which mate with corresponding grooves in the body, provide a rigid unit that resists any tendency to spread under heavy loads.

UNITIZED SLIP ASSEMBLY! And here's where the crew cuts operating time. The Slip Assembly is *completely unitized*, with the four slip segments attached to a hinged tong. To release the slips, simply lift and spread the tong handles. To set the slips, bring the tong handles together and lower the unit into the Spider.



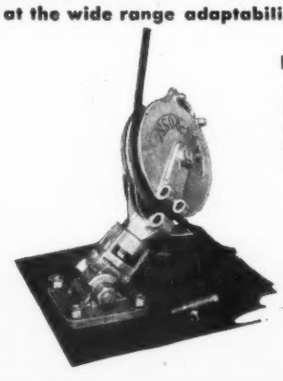
Because the slips are completely unitized, they *always* set at the same level, regardless of whether the tubing is centered or not. This speeds work, eliminates resetting, and safeguards the tubing. There's no risk of swaging or damaging the tubing through uneven slip setting.

And here's another money-saving feature—*by simply changing the slips*, one Spider handles a complete range of tubing sizes . . . 1¼", 1½", 2", 2½", 3", 3½", and 4". You get maximum adaptability at minimum cost!

No Lost Time!

THE BAASH-ROSS UNIVERSAL UTILITY BLOCK

Here's a Block that will handle jobs normally requiring *several* different types of blocks. It not only cuts your block investment to a minimum, but also saves vital crew time searching for special-purpose blocks. Look at the wide range adaptability of the Universal Utility Block . . .

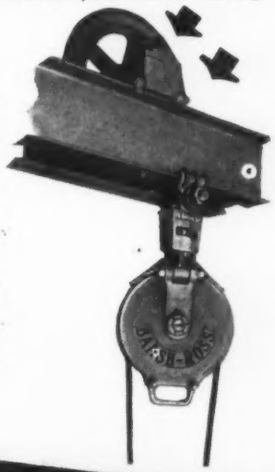


IT'S A FLOOR BLOCK! Attach the Base Plate, and the Utility Block becomes a floor block with positive stops at 45° in any direction to the floor and full-swiveling action to follow the line freely. For maximum convenience, install a Base Plate on each rig and move just the Block itself!

IT'S A TUBING BLOCK! Attach a Clevis below the swivel and the Utility Block becomes a single-sheave tubing block. The Clevis swings freely from side to side, but the swivel can be locked against rotation if desired. The heavy duty roller bearing construction gives a 78,000 lb. working capacity—ample for most well-servicing.

IT'S A BAILING AND CORING BLOCK! Attach a Beam Hanger and the Utility Block can be suspended from the base beam of the crown for bailing and coring operations at shallow and medium depths. The full-swiveling and tilting features in the Utility Block assure its following the rope freely.

Maximum convenience in *all* operations is provided by the side-opening feature that permits placing the line around the sheave quickly and easily. Throughout, the Utility Block is built for heavy-duty work . . . full tapered roller bearings in *both* sheave and swivel . . . provisions for high-pressure lubrication direct to each bearing . . . all-steel construction with flame hardened groove . . . and a 78,000 lb. working capacity with a safety factor of 2 to 1!



In addition to the advantages outlined in the above Baash-Ross production tools, there are many other unique features that save time, increase crew efficiency, reduce maintenance and inventory costs. Your nearby Baash-Ross distributor will gladly give you complete details . . . or write direct!

Oklahoma in 1945 passed an act[24] providing, among other things, for the creation, under certain conditions and in accordance with prescribed procedure, of units necessary effectively to carry on cycling operations.

In 1945 Alabama,[25] Florida,[26] and Georgia[27] passed conservation laws, each of which authorizes the regulatory body entrusted with their enforcement to require the cycling of gas and to compel the pooling or intergration of tracts when reasonably necessary in connection with cycling operations.

● **Conclusion.** The Texas Legislature in 1945 recognized, to a limited extent, the importance of pooling in connection with gas operations, as it passed an act[28] authorizing the Commissioner of the General Land Office with the approval of the School Land Board to enter into agreements pooling with other interests in natural gas the state's royalty interest therein (except under leases covering Texas University lands) and passed another[29] authorizing guardians of the estates of minors and other persons to enter into pooling agreements covering the interests of their wards in gas and gas rights so as to pool or unitize such rights with similar rights in other lands and prescribing the procedure to be followed.

No legislation has been enacted in Texas giving to the Railroad Commission the power to require cycling and pooling or unitization necessary incident thereto. Texas in this respect has not kept pace with the progress of legislation in other states or with the technological development in the field of gas cycling, despite the fact that it has been authoritatively estimated that approximately 82 trillion cu. ft. of an estimated 140 trillion cu. ft. of gas reserves in the United States[30] (as of January 1, 1945, computed on a pressure base of 16.4 lb. per sq. in. and at a temperature of 60°F.) are situated in Texas.

As pointed out above, operators have been successful in effectuating cycling programs in gas fields in Texas by voluntary agreements under the statutes; and under the decision in the *Corzelius* case the Railroad Commission has broad powers with reference to prorating and regulating gas well production. It may be found that the present powers of the Commission, under the statutes as now construed by our Supreme Court, are sufficient to prevent the blocking of a cycling program by the refusal of an operator or operators, owning only a small portion of the field, to participate therein or cooperate therewith. Experience in the light of the *Corzelius* case alone can tell.

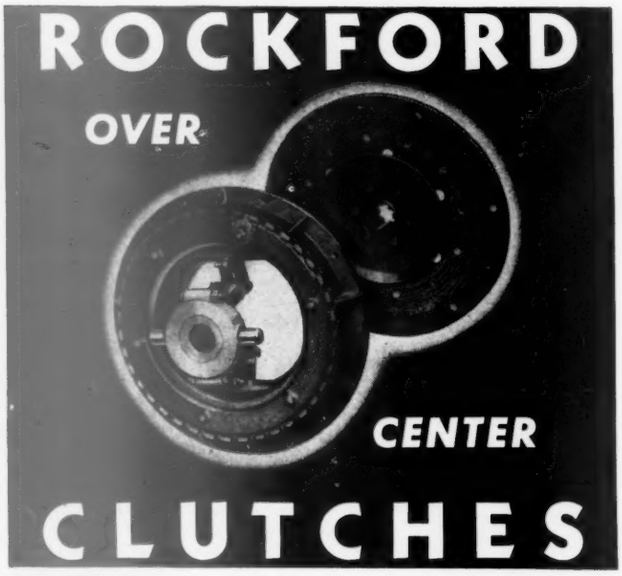
However, if the Railroad Commission of Texas were entrusted with the authority to require cycling operations under proper conditions and to compel the pooling or unitization reasonably necessary for effectuating such operations, there is no doubt that the Commission could prevent the obstruction of a cycling program for a gas field by an operator or operators controlling only a small amount of acreage in the field. Alabama, Florida, Georgia, Louisiana, and Oklahoma have seen fit to clothe their oil and gas conservation agencies with such power, and there is no reason to believe that the Railroad Commission of Texas, with its long experience in oil and gas matters, is not fully capable of exercising similar authority in a manner which would result in conservation practices of benefit to the public generally and to the gas business in particular.

Though this article has been confined to a discussion of cycling in gas fields, it should not be closed without calling attention to the fact that the Texas statute[31] authorizing voluntary agreements for cooperative development applies to gas fields only and makes no provision for such agreements in connection with an oil stratum in which there is a gas cap. ★★★

[24] H.R. 339, Okla.Legis., Reg. Sess. (1945).
[25] H.R. 46, §13, Ala.Legis., Reg. Sess. (1945).
[26] H.R. 284, §22, Fla. Legis., Reg. Sess. (1945).
[27] Ga. Laws (1945), Act 366, §14a.
[28] Tex. Laws (1945) c. 309.
[29] *Id.* c. 80.

[30] Testimony of Dr. E. DeGolyer of Dallas, Texas, before the Federal Power Commission hearing at Kansas City, September, 1945, as reported in the Texas State House Reporter, Oil Regulation Report (Sept. 20, 1945).

[31] *Tex. Stat.* (Vernon, 1936) art. 6008, §21.



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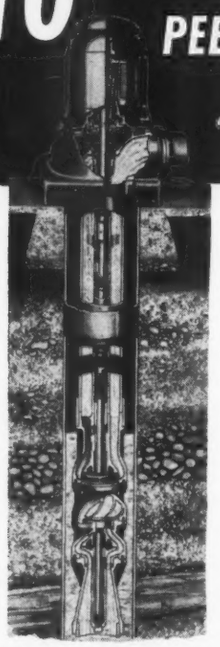

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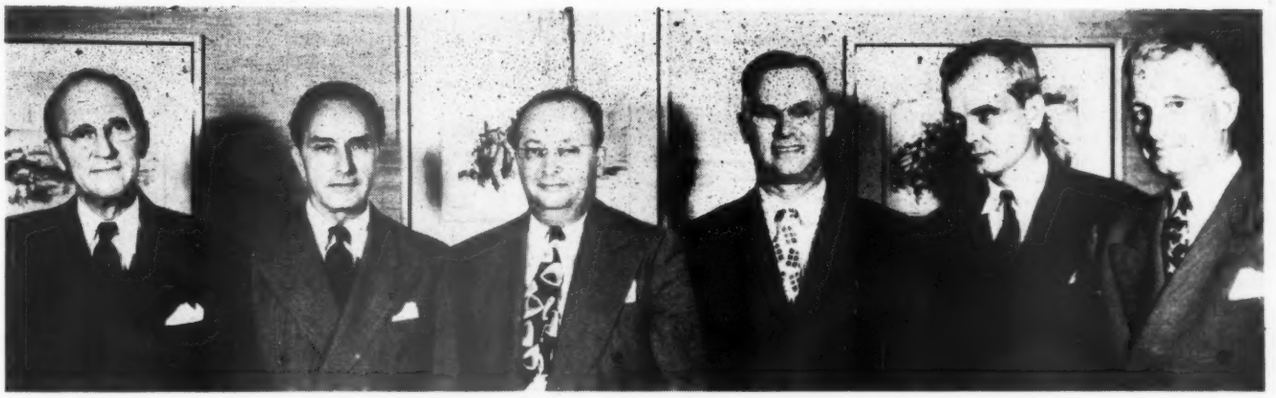
Dallas chapter Nomads organized



Left to right—C. A. McClelland, regent; Arthur A. Burrell, vice president; Noble A. Endicott, president; S. S. Parker, regent; R. B. Moody, assistant sergeant-at-arms, and E. G. Schroeder, treasurer.

A Dallas, Texas, chapter of Nomads was organized June 28 with 36 charter members. The organization meeting was held at the Dallas Petroleum Club.

Noble A. Endicott, Continental Supply Company, was elected president of the new chapter. Other officers are Arthur A. Burrell, The Cooper-Bessemer Corporation, vice president; L. A. Little, Lufkin Foundry and Machine Company, secretary; Eric G. Schroeder, Lucey Products Corporation, treasurer; C. A. McClelland, International Derrick and Equipment Company, and S. S. (Pete) Parker, National Tank Company, regents; R. J. Bauer, Gardner-Denver Company, sergeant-at-arms, and Robert B. Moody, Jarecki Manufacturing Company, assistant sergeant-at-arms.

W. G. Green, from the Tulsa chapter, and chairman of the national board of regents, presided at the installation of the Dallas officers. He was assisted by Shep Miers, secretary to the board of regents.

Emsco holds open house

A large group of Southern California oil men accepted the invitation of K. F. "Ted" Forsyth, local sales manager, to an open house at the general offices and plant of Emsco Derrick and Equipment Company in Los Angeles, recently, and were well rewarded for the effort. The purpose of the fiesta was to witness the operation of one of Emsco's new bulge-type masts, which had been assembled in the yard for the purpose. The demonstration was garnished with some very palatable extras that made it an enjoyable social function, as well as an instructive session.

Under the capable hand—and foot—of S. A. "Web" Webster, sales manager of Emsco's Mid-Continent machinery division, the bulge derrick behaved admirably, while, with the aid of a loud speaking system, he explained the method of operation, and between times, other matters that had nothing to do with bulge masts.

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THE CAVINS DEPTHOMETER

Running Tour WITH MEN IN THE INDUSTRY

• **A. M. Perley,** Oregon district lubrication engineer for Tide Water Associated Oil Company, was elected secretary at a recent meeting of the Oregon chapter, Society of Automotive Engineers. Perley's term of office will last for one year.

• **Arthur J. Koch** has been appointed assistant sales manager of The Hammel-Dahl Company of Providence, Rhode Island. Koch was formerly with the Koppers Company, the Jones and Laughlin Steel Corporation, and Mason Neilan Regulator Company.

• **Samuel B. Mosher,** president and general manager of Signal Oil and Gas Company, has been chosen chairman of the board of directors of the Flying Tiger Line, Los Angeles. Mosher, who founded the oil company in May, 1922, when Signal Hill, near Long Beach, California, came into fame, holds directorships on the board of a number of the country's leading corporations.

• **R. W. Sanborn,** manager of hose sales for the mechanical goods division of The Goodyear Tire and Rubber Company, has been presented with his 30-year pin at the mechanical goods conference. A veteran of the mechanical goods division, Sanborn has served in his present capacity since January, 1939. Prior to that he was mechanical goods district manager at Pittsburgh for seven years. He began his Goodyear career as a clerk in the Akron mechanical goods department in 1916.

• **Dan Duncan,** field engineer of Emsco Derrick and Equipment Company, has returned from an extensive trip to Venezuela where he assisted in the setting up of two Emsco type J-750 drilling rigs for Socony-Vacuum Oil Company in the Guico area. Duncan also spent considerable time in Maracaibo, checking on the operation of power rigs and other miscellaneous equipment with the Richmond Exploration Company, Drilling and Exploration Company, V.O.C., etc. Duncan states that his trip was very successful, and that he found a very optimistic attitude among all people in the industry.

Dan Duncan

• **Dr. Edmund S. Rittner** has joined the research staff of Philips Laboratories, Inc., as associate chemist. His work will be carried on in the Photocell Laboratory. Dr. Rittner received his B. S. degree in chemistry at Massachusetts Institute of Technology in 1939, and his Ph. D. at the same institution in 1941. He held the A. D. Little Post Doctorate Fellowship at M. I. T. during the academic year 1941-1942. During the war he worked on semi-conductors and other important secret projects in the university's Research Insulation Laboratory.

• **Eddie H. Royle,** who has just returned from the service as a pilot in the European theater, is now stationed at Wichita Falls, Texas. He will represent the American Iron and Machine Works Company in the Fort Worth, Dallas, and North Texas territory, handling all sales and service in this area.

• **George Sowards,** assistant to the chief petroleum engineer since February 1, 1942, has been appointed chief petroleum engineer of The Ohio Oil Company to succeed **James D. Wheeler** who was recently appointed manager of the Grand Rapids, Michigan, division. **W. B. Berwald,** division petroleum engineer of the Tulsa, Oklahoma,

George Sowards

W. B. Berwald

division since February 20, 1939, has been promoted to assistant chief petroleum engineer of the company. Berwald will make his headquarters at the general office in Findlay. **Ralph A. Hockenson,** a member of the petroleum engineering staff at Tulsa, has been promoted to division petroleum engineer for that division to succeed Berwald.

• **Scott Thompson,** formerly chief engineer for W. C. Norris, is now with American Iron and Machine Works Company of Oklahoma City, in the capacity of special production development engineer.

• **Ian D. Patterson** has been appointed to the newly created post of assistant manager, chemical product development division, Goodyear Tire and Rubber Company. He will be assistant to **Dr. C. W. Walton.** Patterson joined Goodyear in 1921 as a chemical engineer and tire compounder. From 1927 to 1936 he was chief chemist and development manager for Goodyear Tyre and Rubber Company, Wolverhampton, England. Returning to the United States in 1939, he was superintendent for three years at Goodyear's Pliofilm and molded rubber goods plant, St. Marys, Ohio. During the war he was assigned to military products engineering and tire process development work.

• **Herman H. Vaughn,** who has been treasury and credit representative in the Houston, Texas, office of The National Supply Company, has been named credit manager of the company's Texas division with offices in Fort Worth. Vaughn's appointment became effective July 1 when **Ralph B. Wasson** retired after 45 years' continuous service with National Supply. Before joining National Supply in January, 1944, Vaughn had been in the banking business in Nashville, Tennessee, and later with the Fourth National Bank of Tulsa, Oklahoma, and assistant credit manager of the Frick Reid Supply Corporation.

Herman H. Vaughn

• **Henry Strobel, Jr.,** has been appointed Cincinnati district representative of Hammond Iron Works. Strobel will represent the full line of Hammond services including the designing, fabrication, and erection of tanks of cone roof, breather, sphere, spheroid, floating roof, and vapor-lift design, and also gas holders.

• **R. N. Duncan** was recently appointed manager of the supplies department, Shell Oil Company, Inc., New York. Duncan began his career with Shell in 1927 as a clerk in the cracking department at the East Chicago, Indiana, refinery. In 1933 he became the head yield clerk in the main office at that refinery and two years later was appointed senior clerk in the manufacturing department. In 1940, Duncan was transferred to New York as head supply and statistical clerk in the supplies department. He later became acting manager of the department, which position he retained until his present appointment.

• **Charles A. Mayer** has been appointed assistant engineer in the New York office of The Asphalt Institute, to act in the capacity of an administrative engineering assistant to the general manager. For a number of years Mayer served as a partner in the firm of Dow and Smith, consulting paving engineers. During the war Mayer was associated with the construction of a number of foreign army air bases.

• **Andrew M. Howsley** of Albany, Texas, has been appointed general counsel for the Texas Mid-Continent Oil and Gas Association. Howsley, attorney and independent oil operator in the stripper well area of West Central Texas, will serve as general counsel and also supervise the association's office. He is well known in oil circles having long been active in the Texas Mid-Continent Oil and Gas Association. The association will continue to carry on and expand its research and other services for Texas oil and gas operators, Fred Shield, president, said.

Andrew M. Howsley

• **Russell Ranson** has been appointed sales representative for North Carolina and South Carolina of Electric Machinery Manufacturing Company, Minneapolis, Minnesota. The last seven years Ranson has been with the Clark Controller Company at Cleveland, first as development engineer and later in charge of research and development, during which time he was a director of that company.

• **Walter W. Trout,** vice president and general manager of Lufkin Foundry and Machine Company, was elected member of the executive committee of the American Gear Manufacturers Association at its 30th annual meeting held in Hot Springs, Virginia. At this meeting **Thomas J. Bannan** was elected president; **R. B. Tripp** was elected vice president, and **Walter L. Schneider,** treasurer. **N. G. Gion** was continued as executive secretary.

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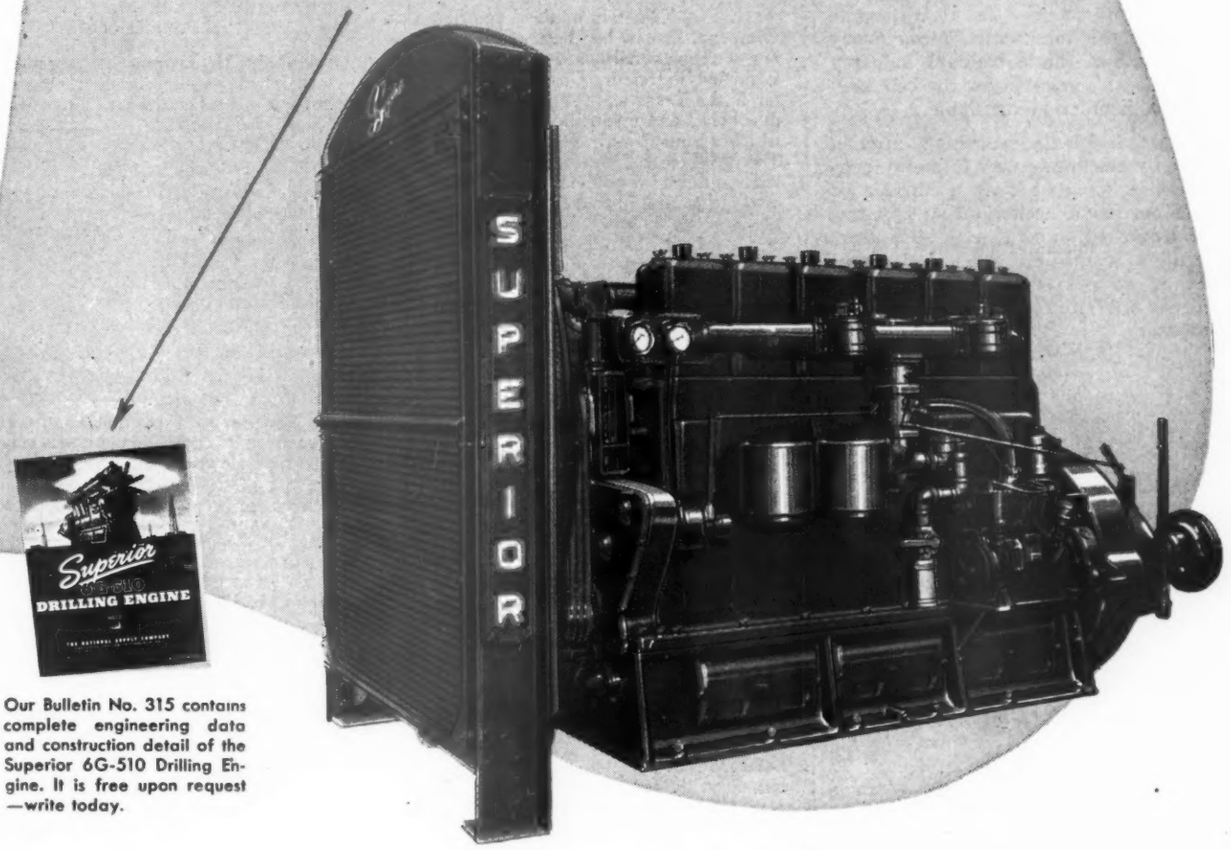
Field performance of the 6G-510 Drilling Engine, as reported by enthusiastic operators, has been truly outstanding. This is no surprise to us, because this drilling engine is not a makeshift adaptation of a general purpose engine, rather IT IS A STRONG, TOUGH, DISTINCTIVELY DESIGNED ENGINE BUILT TO EFFICIENTLY AND ECONOMICALLY FULFILL THE SPECIFIC REQUIREMENTS OF DRILLING SERVICE.



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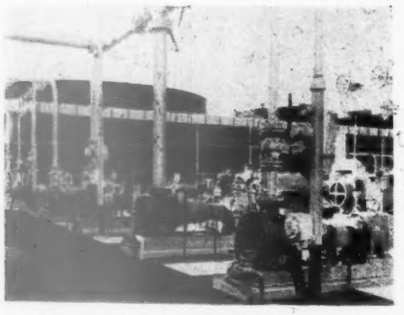

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• **A. C. Long** has been named assistant to the vice president of the foreign operations departments of The Texas Company. He formerly was manager of the executive sales division of The Texas Company's foreign sales department. He has been associated with Texaco since 1930 and has served in various capacities in foreign and domestic operations, chiefly in sales. In 1941, Long left the company on a military leave of absence. He spent 14 months in government service. During much of that time he was petroleum attaché for the State Department in London. **Franz von Schilling** has been named assistant manager of the European and African divisions of the foreign sales department of the company. Since 1942, von Schilling has been on military leave of absence from the California Texas Oil Company, Ltd.

A. C. Long

• **Henry Emmett Gross** has gone into business for himself. He has taken over from his uncle, Herman W. Gross, the making of maps and guides of St. Louis and environs, and has also been doing some consulting work in petroleum engineering. Gross' address is 406 Market St., St. Louis 2, Missouri.

• **R. Field Foster,** of the Lone Star Gas Company, Dallas, has been elected a member of the national board of directors of the Liquefied Petroleum Gas Association. Foster is the Texas state representative on the new board and was named in an election in which all members in his state participated. The new board of directors and new officers were seated at a national convention of the association at Colorado Springs, Colorado.

• **George T. Lundberg,** for the last several years supervisor of transmission design in the engineering department of Caterpillar Tractor Company, has been named assistant to **H. S. Eberhard,** vice president in charge of "Caterpillar" manufacturing, engineering, research and training. **N. E. Risk,** who is responsible for supervision of all engineering and coordinated activity pertaining to the application of allied equipment and special attachments, will also assume supervision of transmission design.

• **Col. Robert H. McLemore,** just relieved from active duty with the Army Air Corps, has announced his association with Well Explosives, Incorporated, Fort Worth, Texas, as vice president and general manager. Colonel McLemore served as group commander and aircraft engineering officer with a B-29 bombardment unit stationed on Saipan. Before being called to active duty in July, 1941, he was associated with Sun Oil Company, Dallas, Texas.

Col. Robert H. McLemore

• **Dr. Foster Dee Snell,** president of Foster D. Snell, Inc., consulting chemists and engineers, Brooklyn, New York, was elected president of the American Institute of Chemists at its annual meeting, succeeding **Dr. Gustav Egloff** of Universal Oil Products Company, Chicago. **Dr. Joseph Mattiello,** technical director of the Hilo Varnish Company, was elected vice president, succeeding **Dr. Donald Price,** technical director of Oakite Products, Inc., New York. At the same meeting reelection of **Dr. Lloyd Van Doren,** patent attorney of New York as secretary, and **Frederick A. Hessel,** president of the Montclair Research Corporation of Montclair, New Jersey, as treasurer was announced. New councilors elected for three years were **Dr. Donald B. Keyes,** vice president of Heyden Chemical Corporation; **Dr. Raymond E. Kirk,** dean of the graduate school and head of the department of chemistry of The Polytechnic Institute, Brooklyn, New York; and **Dr. Donald Price.**

• **C. P. Bowie** has retired as supervising engineer of the petroleum field office at San Francisco, California, after 30 years of service in the U. S. Bureau of Mines. After an extended vacation, Bowie plans to engage in a petroleum industry consulting practice in San Francisco.

A native of Philipsburg, Montana, Bowie was graduated from the University of California with B.S. and C.E. degrees in civil engineering. Before entering the Petroleum and Natural Gas Division of the Bureau of Mines in 1916, he was successively assistant city engineer at Hayward, California, assistant engineer in charge of sewer and street work in the office of the city engineer of San Francisco, city engineer at Chico, California, and, from 1910 to 1916, chief engineer of the Associated Pipe Line Company.

• **Robert H. Owens** has recently been elected vice president in charge of engineering and manufacturing of Roots-Connersville Blower Corporation, Connersville, Indiana, one of the Dresser industries. An engineering graduate Purdue University, Owens has been active in engineering and research since 1912. He joined the engineering staff of Roots-Connersville in 1925, and since that time has been responsible for many new centrifugal blower and compressor developments.

Robert H. Owens

• **R. F. (Ted) Bartlett, Jr.,** has rejoined the staff of the Dallas office of The Cooper-Bessemer Corporation as sales engineer, after five years' service in the army. Bartlett was a staff member of the Dallas office from September, 1934, until March, 1941, when he was called to service as a lieutenant in the Reserve Corps.

• **W. P. McGinnis,** long-time member of Cities Service Oil Company's legal department, resigned from company service and has retired to his ranch near Denton and Ft. Worth, Texas. Widely known in both petroleum and legal circles, McGinnis first practiced law at Wilburton, Oklahoma, after graduating from the University of Texas' Law School. After nine years at Wilburton in the practice of law and as county attorney for Latimer County, McGinnis moved to Muskogee, Oklahoma. While there, he served six years as U. S. district attorney and practiced law three years. He then moved to Tulsa and, after engaging in the law practice there, joined the legal staff of Tidal Oil Company. Sixteen years ago, he joined the staff of Cities Service's legal department.

• **James H. Galloway,** Scott and Hopper district superintendent for Humble Oil and Refining Company, Encino, Texas, has been transferred to the Means district, Florey, Texas. Other company changes in Texas are: **V. O. Harris,** Talco district superintendent, Talco, transferred to Mt. Sylvan district, Grand Saline; **G. N. Anderson,** assistant district superintendent of the Talco district, promoted to district superintendent of the district; **John G. Calvert** transferred from the East Texas division office, Tyler, to the London district, Overton, and promoted to district petroleum engineer; **Tom E. Beaird,** London district petroleum engineer, Overton, transferred to the Hawkins district, Hawkins; **Charles S. Yust** transferred from the East Texas division office, to the Mt. Sylvan district, Grand Saline, and promoted to district petroleum engineer; **J. B. Alexander** transferred from the East Texas division to the Southwest Texas division, Corpus Christi, as division civil engineer, replacing J. M. Carter, who is resigning.

• **Dr. L. L. Nettleton,** an outstanding geophysicist and former head of gravity interpretation for Gulf Research and Development Company, Pittsburgh, has been named a firm member of Gravity Meter Exploration Company, Houston. Nettleton was associated with the Gulf Research for nearly 16 years. He is the present editor of "Geophysics," official publication for the Society of Exploration Geophysicists.

• **Earl L. Chandler** has been transferred from the eastern division to the Dallas, Texas, district of The Axelson Manufacturing Company. Chandler has been connected with the Axelson Manufacturing Company since 1926 and through the period of the last 20 years has worked in many of the Mid-Continent divisions. **William A. "Bill" Russell** is assuming the district vacated by Chandler.

Earl L. Chandler

• **Walter C. Kerrigan** has been appointed manager of the nickel sales department of The International Nickel Company, Inc., to succeed the late **Rudolph L. Suhl.** Kerrigan has been associated with business in metals and ores since 1919. He joined International Nickel in 1930 and has been an assistant manager of its nickel sales department since January, 1933.

• **Herbert L. MacElroy** has been appointed New England representative of the Geo. P. Reintjes Company of Kansas City, Missouri, manufacturers of sectionally supported walls and arches. MacElroy's office will be at 7 Water Street, Boston, Massachusetts.

• **Clement M. Gile** has been elected vice president of the Gulf Oil Corporation and the Gulf Refining Company, and also vice president and a director of the Gulf Research and Development Company, succeeding W. V. Hartmann, retired. He will be in charge of marketing.

• **E. L. Decker,** president, and **"Mutt" Donovan,** sales and service representative of the Martin-Decker Corporation, recently made an extended trip. The latest Martin-Decker products were shown and service information was discussed with Martin-Decker's distributors—Reed Roller Bit Company. Field problems were studied in Colorado, Wyoming, Kansas, Oklahoma, and Texas.

IT'S THE FOOTAGE OF HOLE IN THE OIL SAND THAT COUNTS

Most oil wells cost

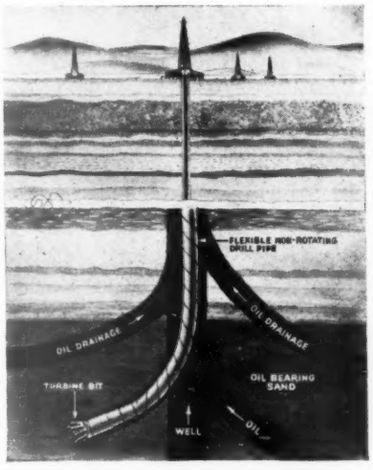
more than $1000 per foot to drill

ZUBLIN DRILLING COSTS ABOUT $10 PER FOOT

Cost of drilling an oil well from the grass roots down through oil sands is determined by the footage of oil sands. You can't produce anywhere but from the oil sands.

Therefore, if your well cost $50,000 to drill and you get 50 feet of oil sand, your drilling has cost you $1,000 per effective foot.

But, by drilling full size horizontal drain holes, to that 50 feet of pay sand you increase the drainage capacity of your well in an amazing ratio.



For instance, drill 6 horizontal holes 80 feet in length and you add 480 more feet of drain area to the 50 feet of vertical drain area.

That's something to think about and worth investigating.

We are prepared to take full responsibility for drilling horizontal drain holes in your wells.

The drilling of drain holes requires no additional casing.

Full details, test records and costs upon request.

Inquiries for Franchises and Manufacturing Rights invited.

TURBINE BIT COMPANY

(Under the ownership of John A. Zublin)

2369 E. 51st St. (Phones: JE. 4433, JE. 6151) Los Angeles 11, Calif.

Zublin

HORIZONTAL WELL DRILLING

BORN
A Year Earlier

Remember the first solo flight, New York to Paris, May 20-21, 1927? Seems sort of ancient now, but it proved the principle of man's mastery over the air. Well,

SAND-BANUM

"The Entirely Different Boiler and Engine Treatment"

BORN IN 1926

proved the mastery over boiler scale and corrosion. Its 20 year record in the automatic elimination and prevention of boiler scale and corrosion shows reduced fuel cost and increased power.

Sand-Banum comes in 16 oz. cans, ready to use as is. It's safe to personnel and equipment.

It results in longer equipment life and reduces shut-downs, despite water or operating conditions.

BE A SKEPTIC

TODAY—*ask us to prove this to your entire satisfaction.*

AMERICAN SAND-BANUM COMPANY, Inc.

9 Rockefeller Plaza, New York 20, N. Y.

Stocks carried by
WESTERN SAND-BANUM COMPANY
Houston, Texas

and at other convenient points including leading supply houses

Export Representatives
PETROLEUM MACHINERY CORP.
30 Rockefeller Plaza New York 20, N. Y.

LAUGH WITH BARNEY

"Do you mean to tell me you murdered that poor old woman for a paltry three dollars?" the judge said.

"Well, Judge, you know how it is. Three bucks here and three bucks there, it soon mounts up."

Bill: I believe the end is near for me. Farewell.

Harry: Why? What seems to be the trouble?

Bill: I bought one of those life-time fountain pens, and it's broken.

Her hat was on the side, her clothes rumpled and her shoes in shreds.

"Were you knocked down by a motorist?" asked a sympathetic bystander.

"No, picked up," she snapped.

"I've been afraid of firearms ever since I was born."

"Why, was your mother scared by a gun?"

"No, but I think my father was."

A woman called up the owner of a restaurant. "Would you mind calling my husband, Barney, the waiter, to the phone?"

"Barney, the waiter?" he asked. "Does he work for me?"

"Yes," she informed, "But just at present he's outside picketing the place."

First Drunk: Shay, bud, watcha know about alligators?

Second Ditto: Don't know any.

First Drunk: I'll just tell you somethin'. The mamma alligator comes along and plop, plop, plop, she lays twelve eggs in the sand. An' then yuh know what?

Second Ditto: Ain't interested.

First Drunk: Well, I'll just tell yuh, bud, the old man alligator comes along and chomp, chomp, chomp, he eats 'em all up.

Second Ditto: Who gives a damn?

First Drunk: Well, mister, yuh'd better give a damn 'cause if the papa alligator didn't come along and chomp, chomp, chomp 'n eat 'em all up yuh's pretty soon be up to your neck in alligators.

A flyer taking his solo flight saw a park down below. He decided to get a closer look. As he zoomed by, he thought he heard the statue in the middle of the park say something. The flyer went back and asked him what he said.

The statue said, "I said I wish I could be an aviator."

"Why?" asked the flyer.

The statue replied, "I just want to get a chance to fly over a pigeon, just once!"

A minister making a call was sitting in the garden with his hostess, when her little boy rushed toward them holding a rat above his head. "Don't be afraid, mother, it's dead. We beat him and bashed him until"—and then catching sight of the clergyman, he added in a lowered tone—"until God called him home."

Woman is a paradox . . . most of them want some worthwhile remembrance to forget a man by!

First Communist: Nice weather we're having.

Second Communist (grudgingly): Yes, but the rich are having it, too.

She was the kind of a girl who wore the kind of dresses that kept everyone warm but her.

FOR SALE: Good pair of shoes; owner going back to Tennessee.

—Detroit (Mich.) News.

In a small fight club the fans were disgusted with the lack of action in the ring. The two battlers did nothing but circle each other, with no punches being thrown. A forbidding silence mounted in the arena. Then—

"Hit him now, you bum," a spectator called. "You got the wind with yah!"

Young man (seated on bus): Excuse, me, madam, but you are standing on my feet."

Old Lady (frankly): Yes, I kind of hoped you'd prefer to stand on them yourself.

An Arkansas hillbilly built a house for his wife in which he fashioned windows but no doors. "Where are the doors?" asked the nervous bride.

He drew himself up to his full height and replied: "Door? Are you going somewhere?"

A man was riding on the subway and noticed that another passenger kept staring at him. Finally he couldn't stand it any more and snapped out: "What are you staring at?"

"Excuse me," said the man, "But if it were not for the mustache, you'd look exactly like my wife."

"But I haven't got a mustache."

"I know," was the reply, "but my wife has."

The general spoke, "Men, we are outnumbered four to one; the enemy is close upon us; we will have to fight to the end. Now, get in there and fight."

The battle raged. Suddenly the general spotted a soldier leaning against a tree, half asleep.

"Private Jones, what's the idea? Men are dying all around you and yet you lie there asleep?"

Jones opened one eye and replied, "Well, sir, I already got my four!"

Salesgirl: Yes, Mrs. Gildedpurse, our girdles come in five sizes—small, medium, large, wow! and Ye Gods!

Farmer Brown had been on a bender in the big city and was suffering from a terrible hangover when he stumbled out at five o'clock in the morning to milk the cow.

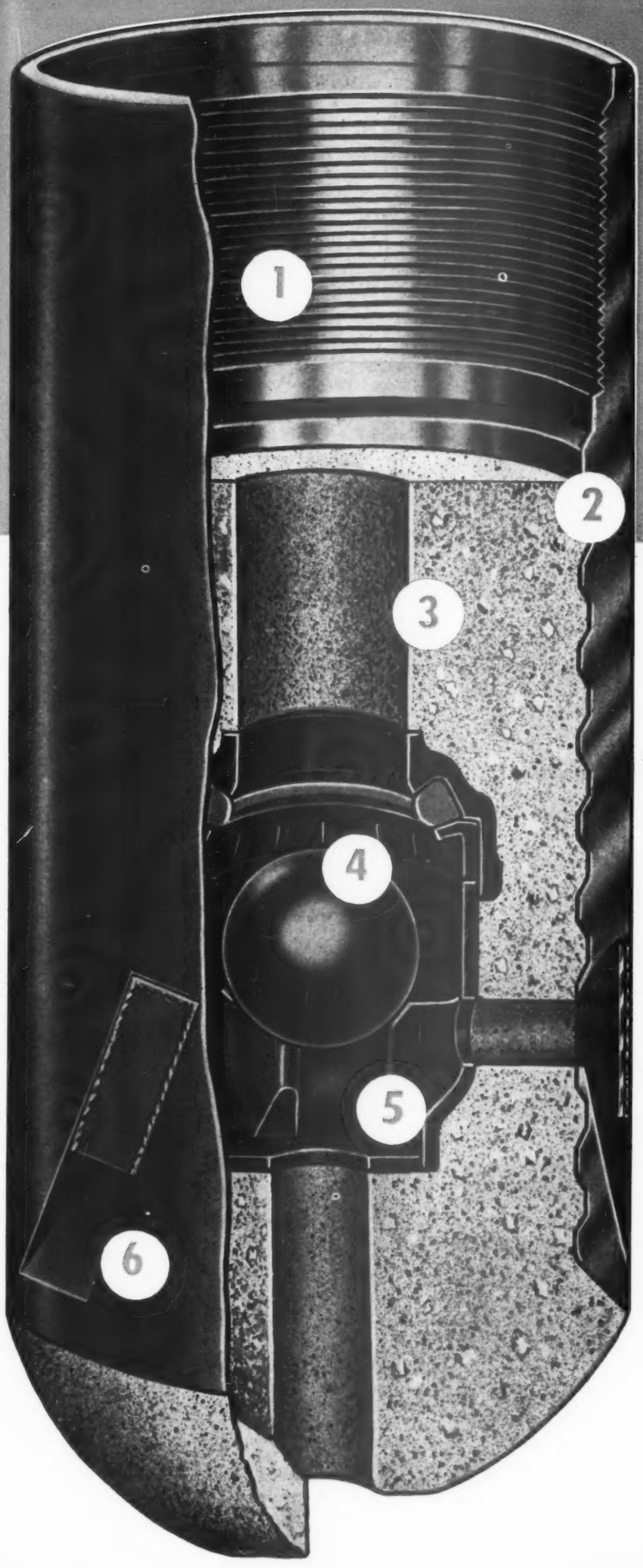
"You look terrible," said the cow, bluntly. "Those circles under your eyes reach down to your knees."

"I know," said the farmer. "And milking you is only the beginning of my troubles. I'll be slaving on this durn farm 'til seven this evening."

"Well," volunteered the cow. "I'll help you all I can. You just hold tight and I'll jump up and down."

He had Tarzan eyes—they swung from limb to limb.

All of us preach the worthiness of hard work. We began praising it centuries ago in an effort to induce others to do our share of it.



Here's the big idea

that reduces cementing hazards to a minimum!

BAKER CEMENT WASH-DOWN WHIRLER FLOAT SHOES

(Product No. 120)

have everything you need for successful cementing...

1. Accurate threads to fit casing specifications;
2. A seamless steel shoe in which a concrete plug and plastic ball-type valve assembly are so securely anchored that it has ample strength for floating the longest, heaviest string of casing;
3. Easy drillability and disposal of plastic and Baker-Formula Concrete;
4. A plastic ball which floats in cement slurry, and instantly seals against a recessed rubber ring if slightest back-pressure develops;
5. Ample circulating areas for any cementing or circulating operation;
6. Wash-down whirler ports which first direct the fluid to condition the hole; and then whirl the cement slurry around the shoe and shoe joint to uniformly encase the pipe and prevent channeling.

You'll do it better with

BAKER OIL TOOLS

BAKER OIL TOOLS, INC. LOS ANGELES • HOUSTON • NEW YORK

HARRISBURG *Oil-Field* PRODUCTS

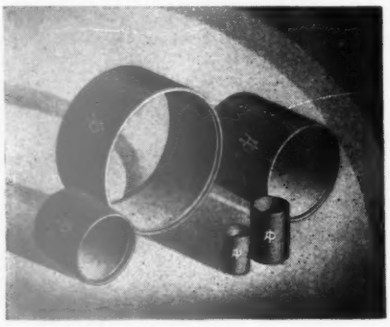
Harrisburg Seamless Steel Oil Field Products

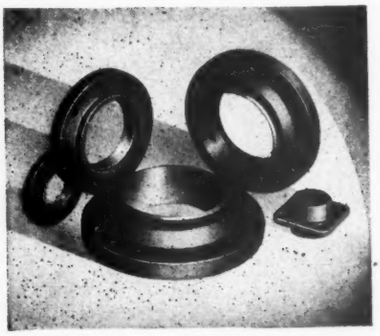
Harrisburg pipe couplings and drop-forged pipe flanges have met the exacting requirements of hard usage in the oil fields for over a quarter of a century.

The precision threading and machining operations are fully as vital to their endurance as the fact that they are processed from Harrisburg's own steels. Harrisburg threads are unexcelled in accuracy of form, height, angle and lead. Due to their superior processing, they will not gall or strip under the severest strains.

Harrisburg drop-forged flanges can be furnished in standard or special types made exactly for your requirements, either in butt welded or screw thread types, and in conformity with ASA standards.

Harrisburg seamless steel pipe couplings conform to API specifications.





Send for these Catalogs

The new Harrisburg catalogs on pipe couplings and drop-forged pipe flanges are full of helpful buying information and related tables printed in large, easy to read type. Send for copies for your files.

HARRISBURG STEEL CORPORATION

HARRISBURG, PENNSYLVANIA

Alloy and Carbon Steels; Seamless Steel CO_2 Liquefiers, Pipe Couplings, Slush Pump Liners and High Pressure Gas Cylinders; Drop Forgings; Forged Steel Pipe Flanges; Coils and Bends

To South America

R. E. Kirberger, sales manager for Franks Manufacturing Corporation, of Tulsa, left Miami late in June, by Pan American Clipper, for an extended tour of the South American oil fields.

R. E. Kirberger

The trip is in the nature of a survey of the needs for drilling and servicing equipment in the major oil producing areas of Latin America, and will include educational presentations in the use of portable oil field equipment. A number of movie films will be used, showing the operation of portable drilling and servicing units.

Kirberger's itinerary includes Trinidad, Barranquilla, Bogota, Caripito, Maracaibo, El Centro, and other points in Venezuela, Colombia, and other oil producing nations in South America.

Sales representative

John H. Moran

Oil Center Tool Company has announced the appointment of John H. Moran to its sales staff. Moran began his career in the oil field business in 1910 in California. He spent four years in the Rocky Mountain area and later engaged in export sales work in New York. He went to Houston in 1939.

Kellex to continue

Plans for utilizing to their fullest peacetime value the top technical talent assembled for the development of the K-25 atom bomb plant at Oak Ridge, Tennessee, have been made known by The M. W. Kellogg Company, process engineers, of Jersey City, New Jersey, and New York, New York. The plans were revealed in a statement by H. R. Austin, president of that company, announcing that A. L. Baker had been elected vice president of The Kellex Corporation, and W. H. Denne, Jr., general manager. The Kellex Corporation is the Kellogg subsidiary that engineered the Oak Ridge plant.

A. L. Baker

W. H. Denne, Jr.

Originally formed on a war duration basis for the sole purpose of completing the atom bomb project, the Kellex Corporation developed a wide range of new scientific methods, procedures, and equipment in the course of its work on that task. Interest in these results of its operations has become so gen-

eral, Austin stated, it was decided that the technical skills and experience available in Kellex could be utilized for the benefit both of government and industry in development work in the most advanced scientific fields.

Bethlehem promotions

J. G. Floyd has been promoted to district manager of the Ark-La-Tex District of Bethlehem Supply Company, according to C. C. Crider, division manager. Floyd will have his headquarters in the company's new store at Shreveport, Louisiana. He was first em-

J. G. Floyd

R. E. Williams

ployed by Bethlehem as field representative in October, 1941, and was given leave of absence in January, 1942, to re-enter the military service. Floyd succeeds Fred Parks who was recently promoted to resident manager at Houston, Texas.

R. E. "Peck" Williams who joined the Bethlehem organization as assistant district manager of the Panhandle District has been named district manager of that district by V. W. Bailey. His headquarters will be at Pampa, Texas.

Thermoid appointments

Jack Owen, manager, oil field products division of Thermoid Company, Trenton, New Jersey, announces the appointment of Paul Kelting as field manager of the division and Earl Johnson as oil field product sales representative in Oklahoma.

Paul Kelting

Paul Kelting joined Thermoid in January 1945 as district manager of the Houston branch. He will supervise sales and service activities in Mid-Continent and Gulf Coast areas.

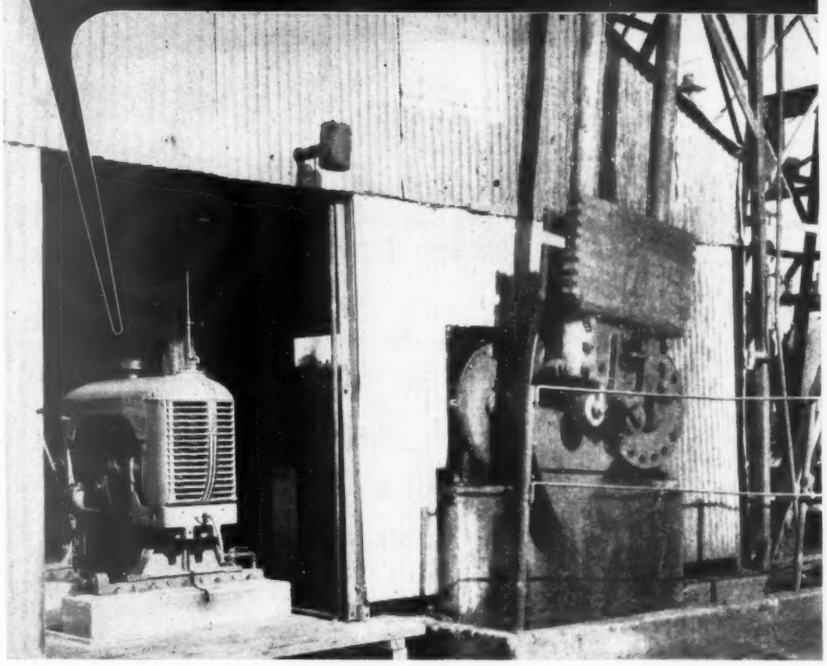
Earl Johnson joins Thermoid from the Green Head Bit and Tool Company. He is making his headquarters at Oklahoma City.

Rejoins Petreco

L. C. Waterman

Major Logan C. Waterman has rejoined the Petroleum Rectifying Company after serving in the Army Air Forces for approximately three and a half years. Waterman spent two years overseas, in Australia, New Guinea, the Philippines, China, and Japan. He will now be at the Petreco Houston office in an executive engineering capacity.

Long Time
No Shutdown



PUMPING WITHOUT PAMPERING

Occasionally we hear about a Case Oilfield Engine that has run non-stop for a year or more, even up to two years. Such exceptional runs reveal the extra ENDURANCE which has earned the respect of oil operators for Case engines.

This endurance reduces the risk of forced shut-down, cuts down the attendance required, makes minor maintenance really minor, puts off the day of major overhaul. Case endurance comes mainly by making every part a bit better than might seem necessary.

Shown above, taking 240 barrels daily from a 4500-foot well in Orange County, California, on a 24-hour, 7-day schedule, is the 42 H.P. Model "DE." Other sizes are the "SE," rated at 28½ H.P. and the 61 H.P. Model "LAE." For full information call the distributor who maintains service in your area. J. I. Case Co., Racine, Wis.

DISTRIBUTORS

Southwest Machinery Co., 1900 Linwood Blvd., Oklahoma City, Tulsa and Hobart, Okla.
Wm. K. Holt Machinery Company, San Antonio, Texas
Southwest Equipment Company, Dallas and Kilgore, Texas
The Gulf Tractor and Equipment Company, 3100 Polk Street, Houston, Texas

CASE OIL FIELD ENGINES

The New— BOWSER

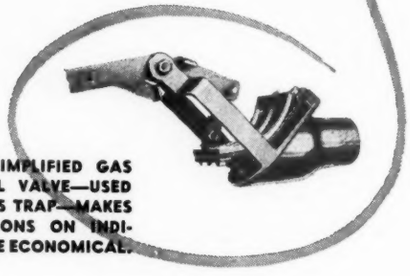
ESTABLISHED 1885

GAS TRAP . . . for OIL WELLS

FIG. 426 GAS TRAP

WITH NEW.. SIMPLIFIED GAS AND OIL CONTROL VALVE...

- Eliminates Crude Spill-over into Gas Line
- No Packing Glands
- Operates on Vacuum or Pressure
- No Metal-to-Metal Seats
- No Grinding or Reseating
- Positive Action
- Nothing to Get Out of Order



THIS PATENTED, SIMPLIFIED GAS AND OIL CONTROL VALVE—USED IN THE FIG. 426 GAS TRAP—MAKES METER INSTALLATIONS ON INDIVIDUAL WELLS MORE ECONOMICAL.

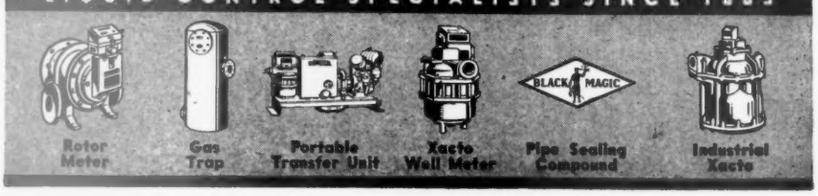
The new Bowser Fig. 426 Gas Trap efficiently separates gas from oil in individual well installations or as a central unit for small lease operations.

It is an important part of the complete Bowser Automatic Well-Check System when combined with the Bowser Proportional Sampler and Special Oil Well Meter.

Write today for complete details on the new Bowser Gas Trap.

BOWSER, INC., 1329 Creighton Avenue, Fort Wayne 2, Indiana

LIQUID CONTROL SPECIALISTS SINCE 1885



Opens Denver office

K. W. Davis, president of Mid-Continent Supply Company, announced that because of the increased oil activity in the Rocky Mountain area, his company has opened a district office at 406 Patterson Building, Denver, Colo.

Barney Blair

Barney Blair is manager of this new district. Blair joined Mid-Continent Supply Company in 1937 at Lisbon, Louisiana. Since that date he has represented the company at Shreveport, Louisiana, Kilgore and Lubbock, Texas, Oklahoma City, Edmond, and Tulsa, Oklahoma, and now Denver, Colorado.

Van Diver leaves UCC

Vernon H. Van Diver, one of America's leading authorities on trade and institutional advertising, has left Union Carbide and Carbon Corporation and opened his own business as merchandising and advertising counselor with offices in the McGraw-Hill Building, New York City. He will also head The Brad-Vern Company, advertising agency at Garden City, New York.

V. H. Van Diver

Meeting postponed

Since formulation by the American Institute of Mining and Metallurgical Engineers of the original plans to hold the World Conference on Mineral Resources in New York City September 16 to 18, requirements for hotel accommodations for the United Nations have been increased to such an extent that it is now evident it will not be possible to accommodate the projected World Conference in New York at the same time. The board of directors of the AIME has therefore voted to postpone the conference and 75th anniversary celebration until the week of March 17, 1947.

The World Conference on Mineral Resources will open Monday morning, March 17, and will close with a banquet on Wednesday night, March 19. Technical sessions for the annual meeting of the Institute will be held the following Thursday, Friday and Saturday.

A. I. Brainard resigns

A. I. Brainard has resigned as president of the Beaumont Iron Works Company, subsidiary of the American Locomotive Company, effective July 1, but will act in a consulting capacity until January 1, 1947. At the present time, Brainard is not ready to announce his future plans and probably will not make such an announcement until after the first of the year.

Returns to Texas Company

After five years and seven months of active duty with the Corps of Engineers, U. S. Army, Frank E. Hangs has returned to The Texas Pipe Line Company engineering department, Houston, Texas. His last assignment was Petroleum Officer, Shanghai, China, as Lieutenant Colonel.

Heads Marmon-Herrington

A. W. Herrington, chairman of the board of directors of Marmon-Herrington Company, Inc., Indianapolis, Indiana, announces that Bert Dingley retired as president of the company, effective July 1. He is succeeded by David M. Klausmeyer, who has resigned as plant manager of Chevrolet Commercial Body Division of General Motors Corporation to join the Marmon-Herrington organization.

D. M. Klausmeyer

Dingley's retirement climaxes a long and colorful career in the automotive industry. He joined Marmon-Herrington in January, 1932, as vice president, just a few months after the company was founded.

Klausmeyer is well qualified both by education and experience for this important position. A mechanical engineer by profession, he has been identified with the automotive industry all his business life. He joined the Chevrolet Division of General Motors in 1924, after spending three years in body design and manufacture with various factories, and remained with that division continuously for 22 years.

Additions to staff

The staff of field welding engineers of The Lincoln Electric Company, Cleveland, Ohio, has been augmented by the following additions, according to an announcement from C. M. Taylor, vice president:

Gordon Appleby has joined the welding engineering staff of the concern's Philadelphia, Pennsylvania, branch office.

Terril S. Hoffman has been assigned as welding engineer in the St. Louis, Missouri, area.

E. James Langhurst was named welding engineer in the Chicago territory.

Garret S. Parsons has returned to the Los Angeles branch office as welding engineer after three years' Army service.

Letsinger retires

Paris E. Letsinger has been elected a director of the Cummins Engine Company, Inc., Columbus, Indiana. His appointment, which followed his retirement as vice president in charge of distribution because of his health, was announced by C. L. Cummins, president, at a recent formal dinner honoring Letsinger.

P. E. Letsinger

Letsinger, connected with the company for 13 years, played an important part in the growth of the Cummins Engine Company, pioneers in the development of the high speed diesel which is today widely used in many industries.

To increase facilities

An extensive program of improved facilities at the plants of National Tube Company at Lorain, Ohio, and Gary, Indiana, to enable that company better to meet the estimated future demands for steel pipe is announced by C. R. Cox, president of this United States Steel subsidiary.

An entire new Bessemer steel plant, including three Bessemer converters and all necessary auxiliary equipment, will be installed at Lorain to replace the existing Bessemer steel facilities in that city. The improvements at Lorain also include the installation of an additional mill to produce seamless pipe in the smaller sizes; additions and improvements in the equipment for the production of pipe and boiler tubes; a blooming mill, a bar mill, and a billet mill replacing two existing blooming mills and a combination rail mill.

At the Gary plant where certain government-owned equipment installed during the war was recently purchased by National Tube, an additional seamless mill for the production of small-size pipe will be installed, as well as electric welding equipment for producing tubing up to 5 in. O.D.

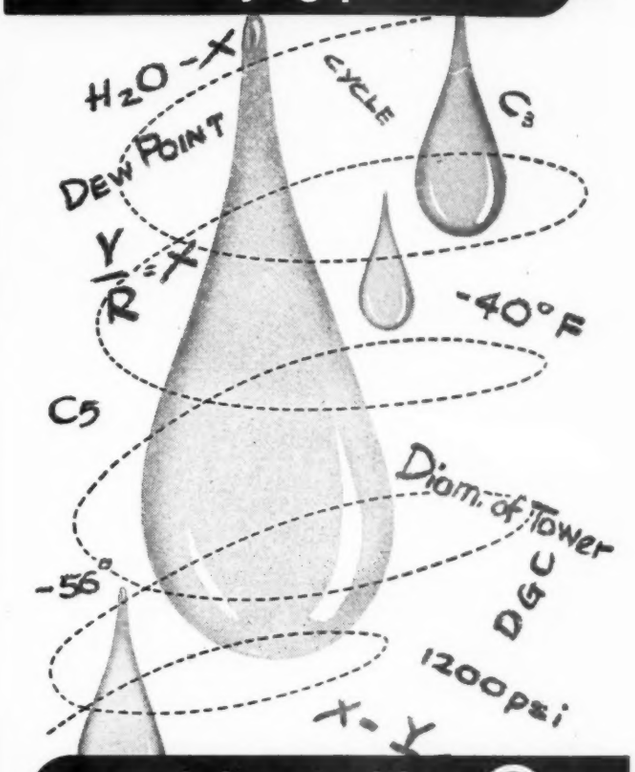
Completion of these two projects, soon scheduled to start, will require about two years, Cox estimated.

Join Cummins staff

Norman E. Palmer, general sales manager of the Cummins Engine Company, Inc., Columbus, Indiana, has announced the appointment of Paul Merkert, Jr., and Robert Miller to the Cummins sales engineering staff.

Both Merkert and Miller joined the Cummins company upon their release from active duty with the United States Navy. Prior to his Navy service, Merkert was with the Murray Corporation as sales engineer on manufacturing accounts. Miller recently was released from active duty with the rank of lieutenant commander.

If it's a drying problem...



...work it out with DRIOCEL

Problems encountered in the drying of gases and liquids have the annoying habit of becoming process puzzles . . . taxing all the arts and sciences of the engineer. And, today's exacting requirements of low moisture content in many materials, adds to the quandary. But, to *know* how well a desiccant will perform solves much of the puzzle . . . and in many uses, under widely varying conditions, Driocel's superiority as a desiccant is performance-proved.

For instance, Driocel has exhibited a D.G.C. of approximately 10% when drying wet gas feeds presenting appreciable temperature, pressure and moisture ranges. Driocel produces dried gases of extremely low dew-point, below −57° F. What's more, its D.G.C. value is little affected by repeated regeneration. Driocel is just as efficient in the drying of hydrocarbon liquids, liquid organic chemicals, electrical oils, hydrogen, hydrogen sulfide and compressed air.

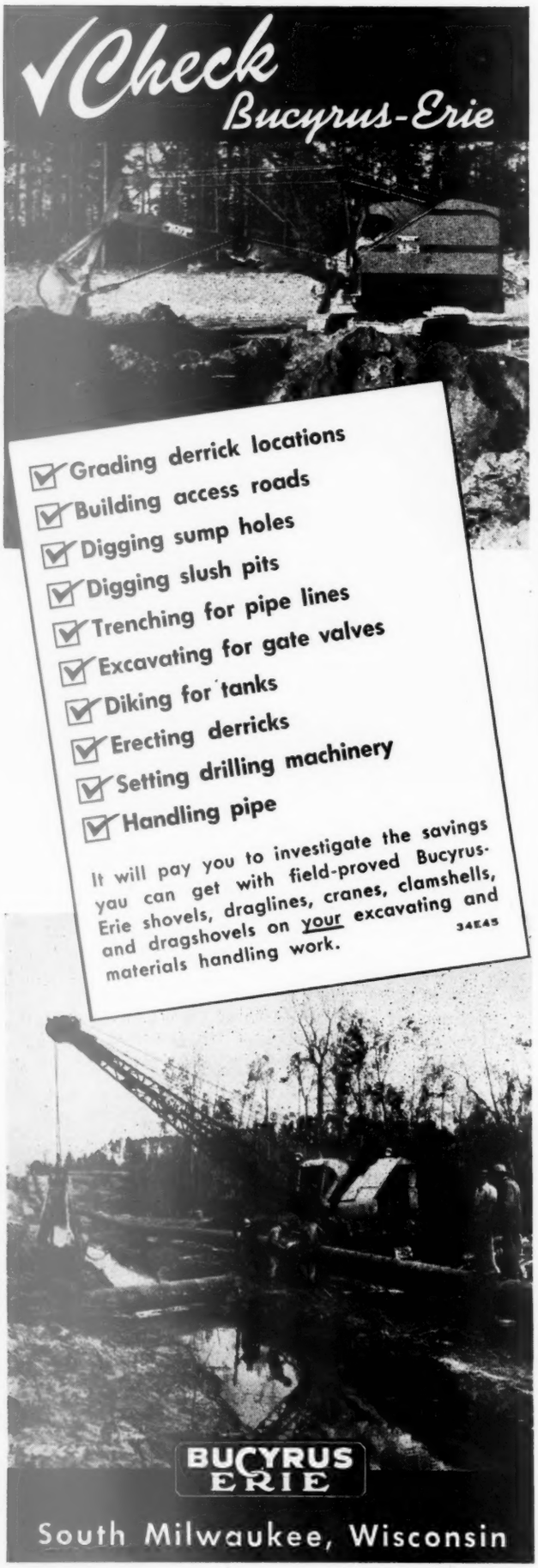
Reasons? Driocel is a "tool" built to do a job, by engineers who fully understand the function of a desiccant. It's made from selected bauxite ore, specially processed to insure high moisture adsorption and low iron content.

If you are faced with a drying problem, old or new, look into the merits of Driocel. It will perform a surprising job in most applications. And, you can be sure of sound advice on drying procedure when you write:

Attapulgus Clay Company (Exclusive Sales Agent)
Dept. J, 260 S. Broad Street, Philadelphia 1, Pa.

POROCEL

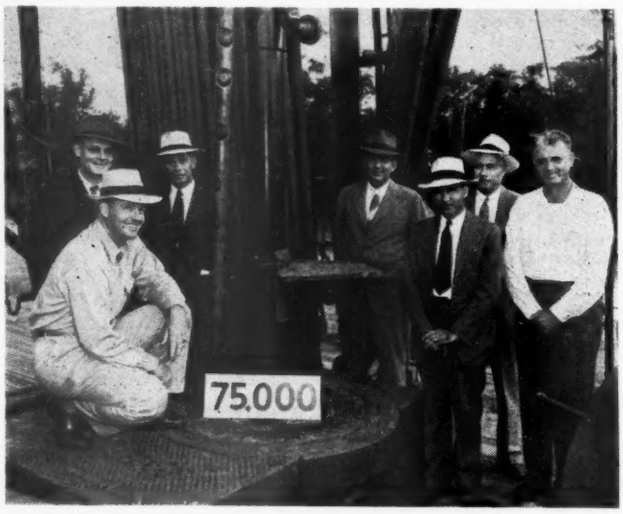
Bauxite Catalysts • Catalyst Carriers • Adsorbents and Desiccants



Gun perforates 75,000th well

Lane-Wells Company and The Texas Company officials celebrated May 30 with the gun perforating of Texaco No. 11 W. S. Rhodes in the Conroe field, Montgomery County, Texas. It was Lane-Wells gun perforating job No. 75,000 and a regular workover job for The Texas Company. The latter was represented by A. B. Patterson, assistant division manager, L. T. Tighe, superintendent of drilling, Jack Wear, field foreman, and J. B. Evans, engineer. Lane-Wells Company was represented by Morton T. Higgs, Gulf Coast division manager, John J. Neale, division sales manager, and D. B. Wheeler, district superintendent.

Lane-Wells gun perforated its first well in December, 1932, in Santa Fe Springs, California, and introduced the service to the petroleum industry at that time.



Shown are J. B. Evans, J. J. Neale, A. B. Patterson, M. T. Higgs, L. T. Tighe, W. C. Kneale, and J. M. Wear.

Joins Southwest Supply

Homer McDuff has been appointed district manager of the territory embracing the states of Arkansas, Louisiana, Mississippi and Alabama, according to a recent announcement by Shep Miers, vice president of the Southwest Supply Company of Pittsburgh, Pennsylvania. Offices have been opened in the Commercial National Bank Building, Shreveport, Louisiana.

Homer McDuff

McDuff has served many years in the oil business. He was general superintendent of drilling and production for the Pure Oil Company in the Fort Worth district, and general drilling superintendent for the Standard Oil Company of Venezuela, with headquarters at Caripito, Venezuela.

After leaving the Standard in Venezuela he returned to Shreveport and was appointed superintendent of drilling and production for the Southern Production Company. He left the Southern Production to join the Rubber Development Corporation (a government agency) as general manager of the Amazon Valley based at Belem, Brazil. He returned from Brazil after V-J Day.

Firms merge

The Atlas Lumnite Cement Company has been merged into the Universal Atlas Cement Company, according to an announcement by the latter company. Both companies are wholly-owned subsidiaries of the United States Steel Corporation. Effective July 1, 1946, the organization of the former Atlas Lumnite Cement Company will be known as Lumnite Division, Universal Atlas Cement Company, with headquarters at 135 East 42nd Street, New York 17, New York. The manufacture and sale of Lumnite, a special hydraulic cement widely used for industrial purposes, will be continued under the direction of Joshua L. Miner, vice president, Lumnite Division.

Bethlehem opens new store

Bethlehem Supply Company has opened a new store at Eunice, Louisiana. The personnel will be J. C. Daigle, store manager, Curtis Stripling and Durwood Dick, floormen. This store comes under the direct supervision of J. B. Ellzey, district manager, who has his headquarters at New Iberia, Louisiana.

Rejoins New York staff

C. J. Havekotte

C. J. Havekotte has returned to the New York branch office of The Cooper-Bessemer Corporation in the capacity of sales engineer, following an absence of four years in military service.

Havekotte began his career with the company in the engineering department at its Mount Vernon, Ohio, headquarters in 1938 and was transferred to the sales department in 1939.

Shortly before reporting at the Aberdeen Proving Ground Research and Development Center in Maryland August 7, 1941, Havekotte began his duties in the New York area.

New purchasing agent

C. K. Sherk

C. K. Sherk has been appointed purchasing agent of the merchandising division of The National Supply Company, according to an announcement by A. W. McKinney, vice president and general manager of sales. The merchandising purchasing department, with headquarters in Toledo, Ohio, does all buying for The National Supply Company stores situated in approximately 100 different points throughout the various oil fields of the country. Sherk succeeds John Kirby who will remain with the company in an advisory capacity for some time and then retire. Kirby has been with National Supply for 51 years.

Hardy chief engineer

A. A. Hardy

A. A. Hardy has become chief engineer for W. C. Norris, Manufacturer, Inc., Tulsa, Oklahoma, to succeed J. Scott Thompson who recently resigned to go with American Iron and Machine Works at Oklahoma City. Hardy graduated in civil engineering from the University of Wisconsin in 1927. He began work with the Prairie Pipe Line Company in Tulsa as an engineer and was transferred to the Sinclair Purchasing Department in 1933 after the merger as equipment engineer and buyer. He left Sinclair in January, 1942, to go with the War Production Board as priority manager for the Tulsa and eastern Oklahoma district. Resigning from WPB in 1944 he joined American Manufacturing Company as chief engineer and later assumed additional duties as works manager. He resigned from that company in May of 1946.

Personnel changes

Colonel Robert H. Morse, president and general manager, Fairbanks, Morse and Company, has announced the retirement of A. E. Ashcraft who has for many years been vice president in charge of manufacturing. Ashcraft continues to be a director of the company. C. H. Morse, III, vice president, has been placed in charge of all manufacturing plants and operations.

Henry H. Haase has been appointed manager of the Beloit, Wisconsin, works of the company following the resignation of A. C. Howard.

Krause retires from Lee C. Moore

The retirement of Charles R. Krause as president of Lee C. Moore and Company, Inc., has been announced by Newton Chapin, Sr., chairman of the board.

Krause was associated with the company from April, 1919, to May 31, 1946. In 1920 he went to Tulsa from Pittsburgh as western manager and nine years later was elected president of the company with offices in Tulsa.

Newton Chapin, Sr., will assume the title and duties as president of the company with offices in Pittsburgh. As previously announced on March 1, Norman F. Rohrkaste was named executive vice president and H. J. Woolslayer vice president and general manager.

Kerotest acquires Wiljack valve

Kerotest Manufacturing Company, Pittsburgh, Pennsylvania, announces the acquisition of the Wiljack Company, South Pasadena, California, makers of bar stock valves in carbon and stainless steel.

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Addresses L. A. Nomads

In the absence of Bill Bettis, president, the Los Angeles chapter of Nomads held its June meeting at the Mayfair, with Jim Robinson handling the gavel, and very nicely, too. The buffet lunch idea still seems to meet with unanimous approval, and does add an extra modicum of informality that just makes the entire occasion more enjoyable. There was again a large attendance, among them many foreign guests and out-of-town members. After the usual good time around the dinner tables, Chairman Jim Robinson called on Earl Boggess to introduce Florent H. Bailly, and in doing so Earl paid high tribute to this Venezuelan emissary, who has played gracious host to many an oil man traveling in his area. Earl had just returned from a trip down Venezuela way, so he knew whereof he spoke.

Bailly has lived almost all his life in Venezuela, and in addition is not only keenly observing, but has a fine command of English, so that he was able to present a very graphic picture of changing times and changing trends in the South American republic.

Among the foreign guests introduced by Earl Boggess, who appeared to know every man jack of them intimately, were: J. W. Killingsworth, Iraq Petroleum Company; J. W. Clampitt, Iraq Petroleum Company; Robert B. Loughboro, G. H. Smith, and W. C. Eyre of Aramco, Saudi Arabia; C. H. Majors, Ex Tropical; T. J. Downey, Socony, Colombia; D. P. Murphy, IEPC, Ecuador; B. L. Coker, The Texas Company, Colombia; M. H. Hobbs, Standard Vacuum Oil Company; Eloi Bernadac, Regie Autonome des Petrole, France; George J. LePolles, Regie Autonome des Petrole, France; Amadee Maratier, Societe Forex, France; Ludoric Simulin, Societe National des Petroles d' Aquitane, France; Florent Bailly, Pantepec Oil Company, Venezuela.

All plans have been completed for the wing-ding at the Riviers Club, July 26, with the sordid details being handled by George Trembley, Ray Humphreys, Lee Laird, Dan Duncan, Billy McGraw, and Wally Sawdon.

New consulting firm

M. L. (Verne) Mayfield and L. I. (Bob) Mistrot, petroleum engineers of Houston, Texas, have organized the Production Engineering Service, specializing in complete field reservoir studies, core analyses, evaluation, and production management.

For 12 years on the petroleum engineering staff of Arkansas Fuel Oil Company prior to serving with the Petroleum Administration for War as analyst and assistant district director of the Natural Gas and Natural Gasoline Division, Bob Mistrot has specialized in oil and gas-condensate reservoir studies, core analyses, and production management problems. More recently he was production manager and chief engineer of a large group of independent properties operated by C. J. Brown, in Texas and Louisiana.

A mechanical engineering graduate from the University of Oklahoma, Verne Mayfield was on the petroleum engineering staff of Cities Service Oil Company, chief engineer for Cotton Valley Operators Committee, an official of the Petroleum Administration for War, and technical advisor-engineer to the Petroleum Industry Committee prior to entering the consulting field.

The company's offices are in the Mellie Esperson Building.

Sales manager McKissick Products

Paul V. McGivern has been appointed sales manager of the McKissick Products Corporation, Tulsa, Oklahoma.

McGivern has been associated in the oil field supply and speciality business for more than 30 years. He was born in Cygnet, Ohio, and went to Oklahoma in 1910. He was employed by the National Supply Company for 11 years and for 21 years by Baker Oil Tools, Inc.

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CNGA frolic

A decided success was the first postwar June Frolic of the California Natural Gasoline Association, held at the Rio Hondo Golf Club in Downey, just outside Los Angeles, when some 600 members and friends gathered for a day of relaxation and entertainment that was a honey. The big event, as usual, was the golf tournament, in which 175 otherwise normal people teed off, beginning at 7:30 a. m., and in most cases were not seen again until the moon was high in the heavens. (P. S. The moon was not the only thing that was high.)

Officiating as starter was Scotty Chisholm of Tam O'Shanter fame, whose kilts and burr provided the proper Caledonian atmosphere for the event. In the annual playoff between the CNGA and the Natural Gasoline Association of America, the latter won by four divots.

For non-golfers, there were games of every known description, and some for which no adequate description has yet been found. A baseball fracas between two groups, the Cumbersome Nine and the Downey Butterfingers, was won hands down by Ham Bell, the umpire. Paddle tennis was added to the list of games this year and proved very popular since the paddles could be used for other purposes besides missing the ball. In the early evening the chow line formed and generous helpings of barbecued meat and trimmings were handed out to all and sundry. Meantime to aid digestion, Shirley Grey was again on hand with her accordion, and Ernie Adams as usual organized miscellaneous quartets, some of which sang in tune.

When the feast was over, Ken Harlan staged another of his variety shows, which was fully up to CNGA standard.

Behind the schedule of successfully conducted events were the following arrangers: R. A. Brock, Southwest Welding; Jim Gesner, Reliance Regulator Company; Phil Mettling, Cooper-Bessemer; Ted Rees, Southwestern Engineering; Jim Richardson, Bechtel McCone; Tom Webb, Clark Bros.; Roland Raasch, Ofco Company; Wm. Morgan, Crosby Steam Gage; Harold Dresser and Ed Bishop, Fluor Corporation; and, of course, George Tyler, CNGA's secretary.

Appoints applicators

The Green Contracting and Engineering Company, Inc., Wichita, Kansas, has been appointed authorized applicators for all Amercoat plastic coatings in the Mid-Continent area.

The Green company is operating portable units for rendering service in the field, plant, or in central storage yard.

In the petroleum and chemical industries, the company is specializing in its exclusive "Pressure Plastic" lining of tubing, casing, line pipe, and other tubular goods; fittings, connections, steel storage tanks and tank cars for handling acids, alkalies, salts, crude and refined petroleum products. In addition, the Green company has insulating crews and spray painting crews for application of external coatings and abrasive blasting, air tool and chemical cleaning.

Houston Nomads meet

Houston chapter of Nomads met June 24 at Ye Olde College Inn. President Charlie Thornhill presided at the meeting, which was attended by 38 members and 17 guests. Guests included Tom McChesney, Phillips of Venezuela; D. J. Rueb, Asiatic Petroleum Company; Ralph Emery, Asiatic Petroleum Company; I. B. Rollins, Standard Vacuum Oil Company; J. G. Dommien, Materials Section of French Government; G. E. Baboin, Schlumberger Corporation; O. B. Rylander, Socony-Vacuum Oil Company; P. Bayle, Texowell Service and Machine Company; George I. Lynch, Lee C. Moore Company; Rex Parks, A-1 Bit and Tool Company; Grover Simpson, independent operator; C. C. Bankhead, Jr., Shell Oil Company; Rodney S. Durkee, Lane-Wells Company; K. B. Cather, Hughes Tool Company; S. H. Harper, Pure Oil Company; L. R. Spencer, International Derrick and Equipment, and Allen P. Berry, Magnolia Petroleum.

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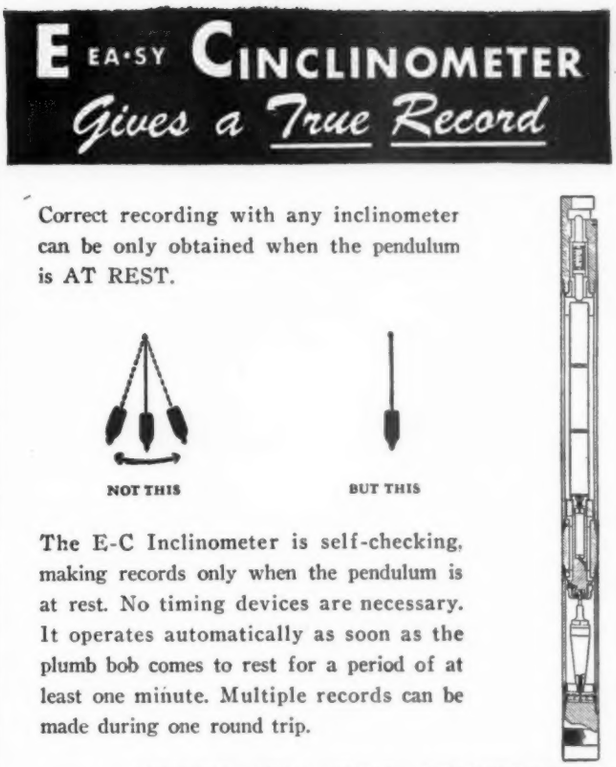
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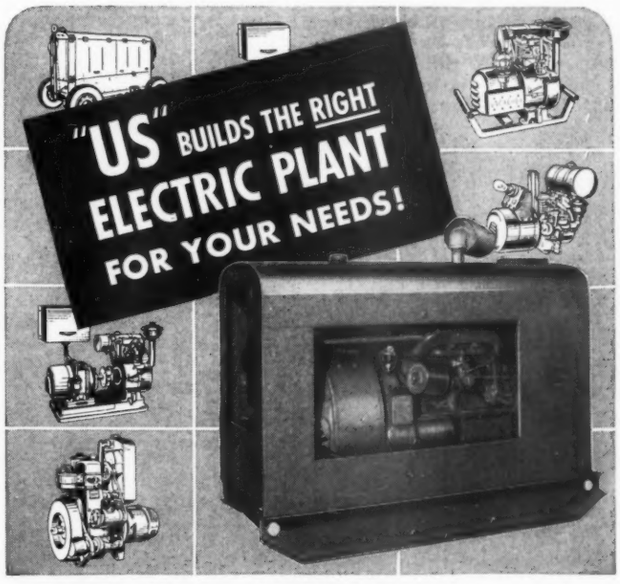
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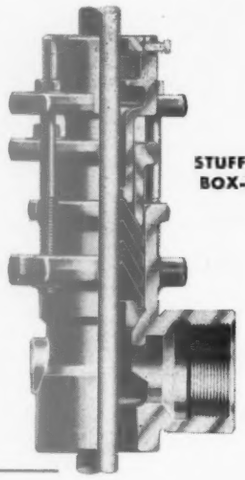

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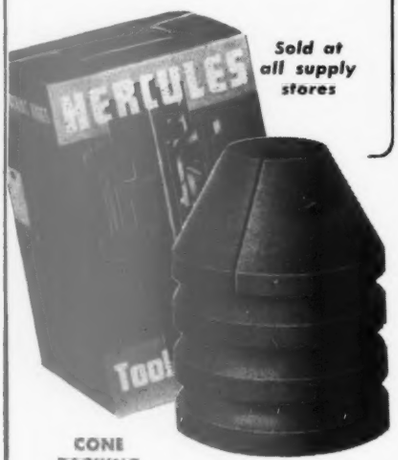

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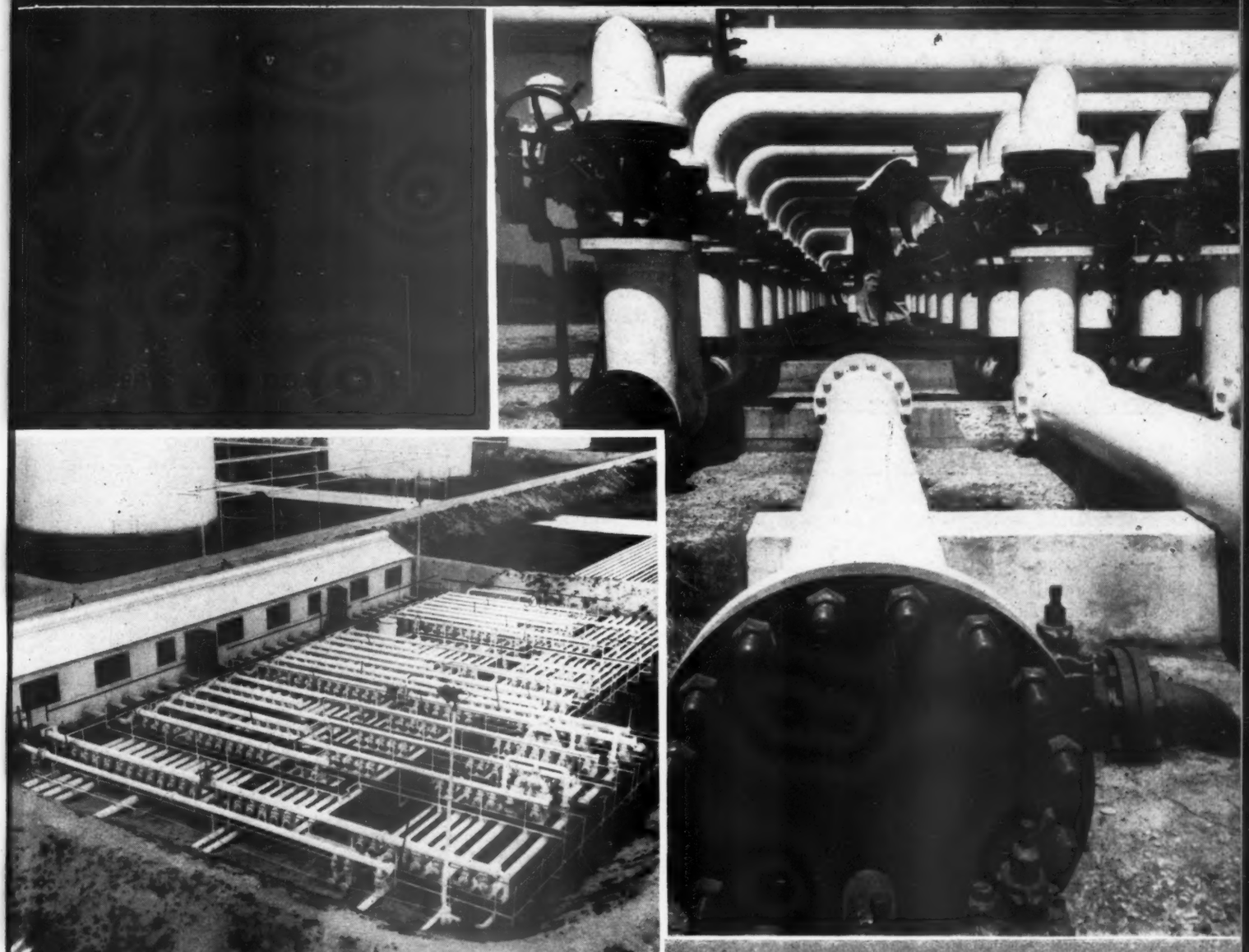
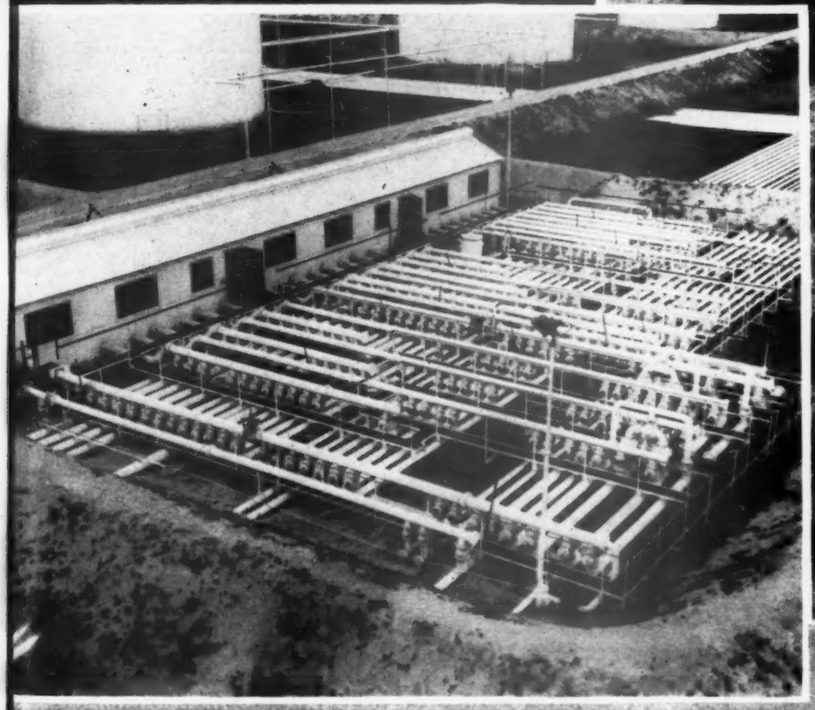


Nordstrom Valves on Manifold System, controlling flow of Products from a Tank Farm to Pumps on the Pipeline. Photo by courtesy Standard Oil Company, (N. J.)



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